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Forthcoming Events.

JANUARY 4.

Institution of Automobile Engineers:—Ordinary meeting in London.

JANUARY 7.

Junior Institution of Engineers:—Ordinary meeting in London. "Distortion in Heat-treated Case-hardened Carbon Steels," Paper by Percy J. Haler, M.B.E.

JANUARY 8.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "The Heat Treatment and Growth of Cast Iron," Paper by J. W. Donaldson, B.Sc., A.I.C.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Foundry Trades Equipment & Supplies Association.

Secretary: K. S. Bridges. Avenue Chambers, Southampton Row, London, W.C.1.

Retrospective, 1926.

It is not a particularly pleasurable occupation to review the principal events of the passing year, so far as they have affected the foundry world. It has been so overshadowed by industrial disturbances that most of our readers will be only too eager to forget its existence. It has added no lustre to the escutcheons of the leaders of industrial thought; it has evolved no new conception of a sure and rapid adjustment of disputes between employer and employed. For many there has been awakened an amorphous idea that a complete divorce between politics and industry is necessary, which may crystallise into a definite expression of opinion that something in the nature of a judicial separation is essential.

The result of the coal stoppage was an almost complete cessation of the pig-iron and coke-making industries, the two basic commodities for the grey-iron foundry trade and an essential for the balance of the industry. Obviously those foundries using very large quantities of coke and pig-iron and relying on their own blast furnaces and coke-oven plants suffered the most. Thus, Stanton, Staveley, Sheepbridge, and Cochranes were heavy sufferers, and we only hope that the swing of the pendulum will give them record outputs and full employment during the coming year. Taking other large foundries engaged in the manufacture of electrical and textile machinery castings, they are to be congratulated on the way they have managed to utilise successfully strange and often inferior raw materials. A branch of the industry which has suffered badly is that catering for the coal mines. Even before the dispute orders were scarce, but for nine months virtually nothing was done. Beyond repair work, little has been done in Great Britain's large marine engineering foundries. This is a deplorable state of affairs, as it is to this section of the industry that we look for a continuous supply of the highest class of skilled moulders, and it is a national disaster that such a fine type of man should be on short time and in a state of mind ready to fall to the blandishments of the emigration agent. In contrast, the automobile foundries have been well employed, and those in control of this industry are so alive to the latest developments for its economic conduct that the most progressive foundries can be favourably compared with any similar establishments in the world.

The malleable-iron foundries kept up in a remarkable manner during the coal dispute, and the largest, that of Leys of Derby, we believe, never lost a day. The steel foundries, however, have suffered heavy losses and many experienced intermittent employment due to the uncertainty of fuel and other supplies.

The non-ferrous casting industry taken as a whole has made good headway. They have been reasonably busy and have had to look carefully at the price of coke as well as the metal market reports. Some have installed oil-fuel melting plants and in general the careful checking of melting costs will make for higher efficiency in the future.

The light castings industry were not only continuously employed, but somehow have managed to maintain very largely their export market. This is an industry which, granted a few more years of good trade—for they have been very steadily occupied during the last few years—will achieve a much better position for themselves. They have been handicapped to a great extent by conservatism and tradition. Many of their buildings and methods are out of date, but we are convinced that they have a true concept of

the best procedure for their development, and undoubtedly when times are more propitious the fullest advantage will be taken.

Another section of the foundry industry in which steady trade has been maintained is the printers' machinery casting trade. The foundries catering for the railways have had rather a slack time. Prices were so cut that no margin was left for the serious advances in the prices of raw materials. Again, the railways themselves are operating their own foundries under such improved conditions that there is but little for the private trader to improve upon. If the various directorates could see their way clear to allow more money to be spent on new plant, instead of forcing those in charge to improvise their own machinery, good progress would be assured. They have surrounded themselves with some excellent managers and foremen, but allow them insufficient scope.

From an international point of view the Convention held at Detroit was a conspicuous success, and it is a real pleasure to reiterate to our American hosts the appreciation the visitors, who without exception, have expressed, either privately or publicly, their delight with the kind and courteous reception accorded to them.

The meeting recently held in Brussels has assured the continuation of such gatherings in an orderly and common-sense manner.

The London Convention, despite the appalling industrial conditions, was of outstanding importtance. Accompanied as it was by an exhibition of foundry equipment it afforded a means of expression of every phase of foundry technical progress. The technical exhibit was universally appreciated, as depicting in an interesting manner the accomplishments and potentialities of the foundry both as a scientific industry and as a craft.

We are satisfied that the British Cast Iron Research Association has established itself firmly as part and parcel of the industry. It is an excellent tool, maintained in first-class condition, and it is for the industry to put it to the best possible use.

The Foundry Equipment and Supplies Association has succeeded in attracting to itself most of the prominent firms in the industry it covers. One of their first decisions was unreservedly to organise and support the technical exhibit referred to above. Generally speaking, the foundries have not spent a great deal of money on new equipment during the past year, and only a few new concerns have come into existence. However, the exhibition had a stimulating effect, and most of those who took space were satisfied with the results achieved. The Institute of British Foundrymen, the representative technical organisation of the country, continues to make real progress, and during the year it has organised a new branch at Middlesbrough, largely through the efforts of Messrs. N. Ridsdale and S. V. Toy. Its foreign membership is rapidly growing, and the anomaly of the non-adherence of prominent foundry owners in towns not served by a local section becomes more complex. If it is worth while for men in the Dominions and foreign countries carefully to follow its activities surely then it must appeal to the hundreds of more or less isolated foundries in Great Britain and Ireland. Now that Mr. Makimson has taken up his duties we hope there will be an intense campaign to interest those foundrymen who can never hope to have the special advantage of a local section.

Contracts Open.

London, S.E.1, January 21. — Circulating water pumps, screens and pump-house equipment, for the Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee 10s. for first three copies, and 10s. for each further copy.)

London, S.W.1, January 7.—(1) Overhead transmission line material and cables; (2) water cranes, for the South Indian Railway Company, Limited, 91, Petty France, Westminster, S.W.1. (Fee, non-returnable, 10s. for each copy of (1) and 5s. for each copy of (2).)

London, S.W.1, January 11.—(1) Steel sleeper keys; (2) crude oil engine generator sets, for the Bombay, Baroda and Central India Railway Company, 91, Petty France, Westminster, S.W.1. (Fee £1 each for (1) and 10s. each for (2), non-returnable.)

An Exceptional Cylinder Casting.

We illustrate below a large drying-cylinder casting which has been recently made at the Edinburgh foundry of Messrs. Mackenzie & Moncur, Limited. This is probably the largest drying-cylinder casting for a paper-making machine which has been made. It weighed about 20 tons, and

A 20-TON CYLINDER CASTING.

required about 30 tons to cast it. It is 12 ft. dia., and the paper-machine makers machine it all over inside and outside, and the outside is then highly polished for the paper passing over. The heat for drying the paper is supplied by steam which is passed through the trunnion of the end plates bolted on to the inside flanges of the cylinder. It is destined for Canada.

The Shanghai Iron and Steel Works, Limited.

The prospectus of turning the Shanghai Arsenal into an iron and steel works, which was drawn up by the chief of the works, Mr. Hu Shu-hua, has been approved by Marshal Sun Chuan-fang. The new factory will operate under the name of the Shanghai Iron and Steel Works, Limited. The chief office is at Kao Chong Miao, Shanghai, with branches to be established later.

The company will be partly owned by the Government, and is capitalised at $3,000,000, including $1,000,000 covered by the land, buildings, machinery, etc., of the old Arsenal, which will be credited to the Government as its interest in the new company. The remaining $2,000,000, divided into $500,000 preferential shares and $1,500,000 ordinary shares, will be open to public subscription. The preferential shares are to be paid for in full before October 31, 1926, and the ordinary shares before March 31, 1927. The shares are to be $100 each bearing 8 per cent. interest per annum, guaranteed by the provincial Government of Kiangsu. Two thousand and five hundred shares out of the preferential shares have been subscribed.

Annual profits accruing from the business are to be appropriated in the following way:—25 per cent. to be kept as reserve fund, 5 per cent. to be distributed as bonus to preferential shareholders, 15 per cent. to be divided among its employees, 5 per cent. to be devoted to the welfare work of the workmen, and the remaining 50 per cent. to be paid as dividends to all shareholders.

HARLAND & WOLFF, LIMITED, Greenock, have received an order to build a modern type of cargo steamer for the Hain Steamship Company, and also a contract for a high-powered twin-screw tug for the Peninsular and Oriental Steamship Company.

THE CLEVELAND BLAST FURNACEMEN, realising the unfairness of a claim for an advance in wages to which the certified average net selling price of Cleveland pig-iron for the present quarter will entitle them, have agreed to forego any advance that becomes due, and wages over the next quarter will be unaltered.

Contraction in Alloy Casting.

BY H. C. DEWS.

(*Continued from page* 544.)

In alloys which freeze through a range of temperature conditions arise which tend to destroy an even solid-liquid interface, and to leave islands of liquid isolated by solid formed in advance of the true-density contours. Alloys which consist of solid solutions invariably show coreing in a normal "as cast" microstructure. This is due to each succeeding layer of solution to be deposited being richer in the lower freezing-point constituent and failing to diffuse into the solid mass. Where more than one constituent is present in the normal alloy it is quite common to find more of the second constituent than equilibrium conditions specify. In the microstructure in Fig. 5, showing a 90: 10 pure copper tin alloy, the ground mass consisting of α solid-solution is seen to be distinctly cored and there are also considerable areas of α-δ eutectoid, which under equilibrium conditions should not appear in alloys containing less than about 13 per cent. of tin. The slow diffusion then in such an alloy brings about during freezing a continual shift in the effective composition of the alloy towards the lower freezing-point side of the equilibrium diagram. When a casting made in such an alloy is freezing there will be near the solid a layer of liquid of a composition which, under equilibrium conditions, would belong to a lower freezing point alloy. Beyond this unstable liquid is liquid of the true alloy composition. If the temperature difference between the two places is small, one can see the possibility of the stable liquid becoming considerably more under-cooled than the liquid adjacent to the solid, so much so that it may reach the labile range and commence to crystallise. This may be illustrated by a diagram such as Fig. 6. Freezing is assumed to have been proceeding from the left-hand side of the diagram, and as freezing has proceeded a layer of liquid has been formed, with a lower freezing point than the normal alloy. The thick line shows the freezing point of the liquid, and the dotted line the temperature of spontaneous crystallisation. Suppose the temperature gradient to be as shown by the thin line. All to the left of A is solid. At the point B is liquid, which is still a little above its freezing point, but further on at C there is liquid which has reached the labile range. Crystallisation will therefore set in at C, with the result that the area B will be isolated and left to freeze out of contact with liquid—that is, beyond the possibility of feeding. That is, a cavity will develop at C. As the same conditions are formed around every crystallite, the casting will be generally unsound. This type of unsoundness can only arise with a low-temperature gradient, as one can see from Fig. 6 that if the temperature gradient is tilted so that it passes under X and over Y, directional freezing is bound to occur. An example of an alloy showing "drawing," due to a flat temperature gradient, is shown in Fig. 7. The cavities are dispersed over the whole section, causing extended unsoundness.

Now revert to the type of diagram which was used to illustrate density changes in pure metals. A similar diagram drawn for alloys freezing through a range of temperature was shown in Fig. 3. Exactly the same reasoning as before may be applied to this diagram, and the same conclusions as applied to pure metals will be arrived at for alloys. Amongst these conclusions was the desirability for a low-temperature gradient in the liquid casting at the moment of freezing. From a metallurgical point of view it has just been shown that a high temperature gradient is desirable. Alloy casting then resolves itself into discovering the happy compromise between a too flat and a too steep temperature gradient. The longer the freezing range of the alloy and the greater must be departure from a flat temperature gradient. In practice temperature gradient is generally most conveniently controlled by casting temperature. It follows, then, that alloys with a long freezing range must be cast at a higher temperature than alloys with a short freezing range. A simple illustration is found in 2F cartridge brass and Admiralty gunmetal. Both alloys commence to freeze at approximately the same temperature, but gunmetal has a freezing range about twice that of brass, and it is found that similar castings have to be poured much hotter in gunmetal than in brass to secure soundness. A very rough working rule for medium melting point alloys is to add the freezing range to the temperature of commencement of freezing to get the approximate casting temperature for average work.

With high melting point alloys which have a fairly long freezing range, an inconveniently high casting temperature would be necessary to obtain a sufficiently steep temperature gradient. This can be avoided somewhat by using a low-conducting mould-material, such as dry silica sand. On the other hand, with lower melting-point alloys, such as those of aluminium, the correct temperature gradient can be best obtained by using a chill mould.

It appears, then, that by a critical control of the steepness of the temperature gradient, and by manipulating the moulding practice so that the temperature gradient slopes evenly from the remotest points to a feeding point, sound castings should be obtainable in most alloys, and the bogey of a long freezing range need not be feared.

The benefits from theoretical reasoning, such as much of the above, can only be obtained by very careful translation into foundry practice, and meetings which encourage co-operation between foundrymen and metallurgists appears to be an ideal occasion for defining the conditions and discussing how to comply with the conditions necessary to securing sound castings.

Foundry Statistics.

During October the UNITED STATES exported 2,641 tons of cast-iron pipes, 749 tons of iron castings, and 429 tons of steel castings. These figures compare with 4,135 tons, 1,047 tons, and 294 tons for the same items for October, 1925. Imports of cast-iron pipes for last October were 6,553 tons.

The imports of pig-iron were 18,847 tons, as compared with 37,709 tons for October, 1925.

During October FRANCE imported 2,470 metric tons of pig-iron and 146 tons of castings, her exports of these commodities during the same period were 55,448 and 33,964 metric tons respectively; 9,241 tons of the former came to Great Britain.

The October statistics for GERMANY show that she imported 7,038 metric tons of pig-iron and 4,867 tons of castings; whilst the exports of these two products reached 51,658 and 19,683 metric tons respectively.

BELGIUM and LUXEMBOURG, which has a customs union, during the month of October imported 821 and 11 metric tons of pig-iron and castings, whilst they exported 17,094 tons and 7,204 tons of these products, 12,602 tons and 618 tons of which came to Great Britain.

The pig-iron output in the UNITED STATES in November was the largest recorded for that month since 1918; it amounted to 3,236,500 tons, or a daily average of 107,883 tons, as against 3,334,132 tons, a daily average of 107,553 tons last October, and 3,023,006 tons, a daily average of 100,767 tons in November, 1925.

Education for Trade and Industry.—The first part of the report of the Committee on Education and Industry (England and Wales) appointed by the President of the Board of Education and the Minister of Labour has now been issued. The terms of reference were:—To inquire into and advise upon the public system of education in England and Wales in relation to the requirements of trade and industry, with particular reference to the adequacy of the arrangements for enabling young persons to enter into and retain suitable employment. The part of the report now published deals with the adequacy of the arrangements for enabling young persons to enter into and retain suitable employment, the term "young person" meaning a boy or girl under the age of 18 who is no longer under an obligation to attend school. The Committee have been in close touch with a similar committee for Scotland and other committees dealing with relevant subjects. The official summary of the Committee's recommendations extends to 34 clauses.

Sheffield Foundrymen Discuss Jolt Ramming.

A lecture on "Some Experiences with Jolt Ramming" was given by Mr. A. L. Key (Manchester) to the members of the Sheffield Section of the Institute of British Foundrymen on the occasion of the November monthly meeting. (The Paper had previously been published in the FOUNDRY TRADE JOURNAL.)

Opening the discussion, MR. GOODWIN said he confirmed the lecturer's general conclusions as to the efficiency of the jolt ramming machine of the type he had dealt with. He had personally installed eight or nine of such machines in his foundry at Sheephridge, and had come to the conclusion that there was nothing more reliable. He did not recollect that Mr. Key mentioned that the small apparatus was a pattern-drawing machine. He thought that was a very great feature of that small turnover machine, namely, that it drew the pattern very ably and was the most mechanically capable machine he had come across. He said he was speaking of the 24-in. by 18-in. machine.

He had not been able to make satisfactorily the top part on the machine where a large, flat surface was needed, and he would like to ask the lecturer if he adopted any special method for maintaining that flat surface. Referring to the remarks of the lecturer in regard to the value of the work done by the Britisher against the foreigner, Mr. Goodwin said that whilst it might appear that the price paid to the foreign workmen was not much greater than the Britishers were being paid for the same production, yet he believed it was a fact, which they were up against, that the foreigner produced more per day than the Britisher. Consequently the foreigners were getting higher wages, and the foreign manufacturers were gaining more than the British manufacturers. The price of the casting in this country was therefore much dearer than the price of the casting in a foreign country.

The question of cast-iron plates versus bars was very interesting. He used both, but found that the latter was more satisfactory in some cases, though he had not been able to discover the reason.

It was interesting to hear a definite figure of the number of jolts required for a specific mould. The question of the amount of overhanging was an important matter, and some of the illustrations they had seen were of castings which he did not think were being made on jolt machines.

Replying, Mr. Key referred to the pattern-drawing machine, and said there was no doubt that they could get perfect form without a particle of breakage. He had had no difficulty in regard to top parts. So far as mass production was concerned, he mentioned that where the foreigner made an article at a cost of 1s., they could make it for 11d., but they only made a dozen, whereas if they had a larger order they could beat the other people. It was the question of large production which counted.

Speaking of the difference between the use of the bar and the plate, Mr. Key said they had not found any trouble from either. It might be due to the fact that in casting the plates they included as many large holes as they could so that there was no surface suction taking place. In the ordinary type of machine, if the sand were not exactly right, they could try for a long time without getting a lift. It was a question of suction.

The number of jolts varied with the different jobs, but no job would take longer than one minute to ram. If there were 200 cub. ft. of sand in their box it could be rammed in one minute. The number was easily determined once they had experimented upon a few patterns, and they could determine almost to a jolt how many were required. It depended largely on the condition of the sand as to whether more or less jolts were required.

In his own practice Mr. Key said he had no semi-skilled labour doing actual moulding operations on the big jobs. He had every confidence that he was producing in a cheaper and more satisfactory manner than with semi-skilled men. They were not doing repetition jobs, but he had machines working with semi-skilled labour. The latter were small jolt machines.

MR. BRADLEY inquired what was the minimum amount of sand between the pattern and box spaced for jolt ramming, and what was the general thickness used. He also asked whether they had to insert plates into the wood for the box to drop on to avoid the box working into the wooden plate.

MR. KEY said the minimum thickness of sand they had for the large-sized box was 3½ in. In regard to the other matter, he said that the largest board they used was 13 ft. 6 in. by 7 ft., and that was made of three-ply hard spruce bolted together with three wrought-iron plates right up the length of the board, with the idea when the plate was in position to accommodate the box, which was flanged instead of having a projection on the top.

MR. BRADLEY explained that he asked the question because in one foundry he knew teak wood was used, and that was expensive, being almost as dear as a cast-iron plate.

MR. MELMOTH said he had learned of jobs done on machines which he would never have thought possible. One point Mr. Key had emphasised, he was pleased to see, for he had had a good deal of experience on small machine work, and that was in regard to the question of tackle. He had come to the conclusion that it was useless considering moulding machines unless they were prepared to co-ordinate it with the necessary tackle. The very best machine could show very little improvement unless this was done—a factor which applied to all machines.

He asked whether the author had found that the cast-iron plates tended to get out of the straight. It was a trouble which he personally had encountered. He had used other materials, such as teak, for the bars, etc., and finally tried steel bars, but found it impossible to get them perfectly flat, so he had returned to cast-iron plates and bars.

MR. KEY agreed that it was difficult to prevent the plates from wearing and maintain them in their correct position, If they could destroy the inner tension by any means the matter would be easier.

MR. R. D. LAURIE, of the Scottish Branch, inquired what was the maximum depth he could ram on a jolt-ramming machine. With regard to the energy expended, he had had a number of years' experience, and realised a considerable amount of work was done by the moulder in ramming. He had thought it impossible to overhang jobs such as had been described, never having seen anything so large as those jobs which Mr. Key had shown them.

Replying, MR. KEY said that with regard to the maximum depth of ramming a box, he never exceeded 4 ft. deep, which covered most jobs.

MR. EDGINTON (the Chairman), referring to the number of jolts required to ram a mould, said he did not think it mattered at all in a machine ramming at 90 jolts per minute if they did 20 or 30 more. Neither did he think they could ram a job too hard on a jolt-ramming machine, but how deep they could ram was limited by the machine. Especially in the case of dry sand work, he did not think they could ram too hard.

MR. KEY agreed that they could not ram a job too hard so far as the surface of the mould was concerned. It depended upon the design of the job in other cases.

Catalogues Received.

Cast-Iron Pipes.—The December monthly stock list issued by the Staveley Coal & Iron Company, Limited, of Chesterfield, is now available.

Valves. — Messrs. Hopkinsons, Limited, of Huddersfield, have prepared an 8-page illustrated booklet detailing the various types of "Mac" valves which they manufacture.

AT A MEETING of the Sheffield Sub-Centre of the Institution of Electrical Engineers, Mr. G. H. Fletcher (chief engineer at the Sheffield works of the Metropolitan-Vickers Electrical Company) lectured on "Electric Locomotive Drives."

The Ironfounder and Direct Iron Production.*

By Chr. Gilles.

Apart from scrap material, the initial raw material hitherto used for ironfounding has been foundry pig. This foundry pig contains, according to the ore used and method of smelting, admixtures of silicon of about 0.5 per cent. to 4 per cent., manganese also 0.5 per cent. to 4 per cent., phosphorus about 0.1 per cent. to 2 per cent., and sulphur 0.01 per cent. to 0.05 per cent.

For decades now foundrymen have been accustomed in arranging for their cast-iron production to rely upon these constituents, allowing of course for any losses or increases, and calculating their charges accordingly. With some degree of certainty they have learnt to run their cupolas so that they yield a cast-iron of definite composition, except, perhaps, for the carbon content, the percentage of which they have been unable to control accurately. They have found that the carbon content, which is contained in ordinary pig-iron in quantities varying from about 3.3 per cent. to 4 per cent., works out at about 3.4 per cent. to 3.6 per cent. in normal cupola working. It has, however, been recognised for many years now that under certain conditions, a lower carbon content may markedly improve the quality of the cast product.

In this connection the work of Zenzes, who obtained a patent in 1902 for a process for producing low-carbon cast iron containing less than 3 per cent. of total carbon is recalled. He achieved this result by mixing converter steel with cupola iron—a mixture that has an appreciably higher temperature than the iron tapped from an ordinary cupola furnace. This product had high strength properties, but the process could not be used commercially owing to the high initial and running costs involved.

A few years later Henning suggested using the product, derived from a similar process, in the form of iron added to the cupola furnace. He took pig-iron from the blast furnace and added to it sufficient liquid steel to obtain a final product—a semi-synthetic pig-iron—having a carbon content of 2.5 per cent. to 2.8 per cent. As a matter of fact, this material proved quite serviceable, and its use, compared to the added steel method, has the advantage of melting more easily and uniformly with the other raw material, because of the higher degree of carburisation.

So long as the cupola was running smoothly good results were obtained with added steel, but, of course, it was not possible, even with a high percentage of the added metal, to obtain a cast iron having a low carbon content. Ledebur has shown that, even when he used 90 per cent. steel scrap, he obtained a cast iron containing over 3 per cent. carbon and, to come down to more recent times, Klingenstein reported last August in "Stahl und Eisen" that where wrought iron is used, the carbon content in an average cast iron works out at 3.1 per cent to 3.2 per cent.

The increasing scarcity of raw materials during the war compelled ironfounders to exercise the strictest economy in the use of pig-iron, and to use greater quantities of steel scrap. It fills the author with dismay to think of the difficulties that arose on that account, and would only recall the ill-famed inverse chilled cast iron which occurred suddenly everywhere. Investigations by Osann, Nielsen, Teichmüller, Adämmer, and, later, by Bardenheuer, Piwowarski and others confirmed almost unanimously that the causes were to be found in the low melting temperature, the high percentage of sulphur, considerable oxide inclusions, and too low silicon and manganese contents. The fact that a lower carbon content resulted here and there in this product is not surprising, but this in itself was no blessing.

It was also during the war that Corsalli made suggestions—conceived from the very urgency of the situation—whereby large quantities of low-carbon iron (especially iron and steel scrap) should be melted, the added iron alloys being protected at the same time by briquetting and encrusting them. Tests made with this process resulted in a decreased absorption of the carbon that had become unprotected owing to the incrustation of the silicon and manganese,† and led him to other suitable precautions, especially increase in the blast volume introduced. In this case Corsalli departs from the old rules of cupola melting and gradually arrives at a quite different method of cupola operation.

The ironfounder has always striven to keep the blast consumption down to the minimum required for obtaining an iron that can be cast well. He recognised, of course, that by increasing the blast-volume to a certain extent, the melting rate and the temperature of the molten iron increased, which was a very desirable feature in itself, but he unfortunately found that whereas the carbon content increased the silicon and manganese losses assumed proportions that jeopardised the economy of production, if not the usefulness of the product. This point has been referred to frequently in the earlier literature as well as in more recent work. In No. 20 of "Die Giesserei" for May 17, 1924, are published three Papers awarded prizes by the Union of German Ironfoundries, and dealing with modern cupola operation. In all three Papers, by Wagner, Spolders-Schulte, and Schmid respectively, references are made, particularly in Schmid's work, to limiting the blast volume in view of the risk of losses arising.

Corsalli's Process.

In this Paper balances relative to heat and materials have not been considered, as they are not necessary for judging this process. For brevity, the Corsalli process will be designated by the latter "C" and the normal process with the letter "N" in the following remarks.

Whereas, in the case of "N," the charge is completed in the recognised manner, the charge in "C" is a kind of "unit charge" consisting of about two-thirds steel or wrought-iron scrap, and one-third runners and risers, and other scrap from the preceding heat. This mixture may, of course, be greater or smaller according to the nature of the castings. The charge has approximately the following analysis:—C, 1.0 to 1.2; Si, 0.6 to 0.8; Mn, 0.3 to 0.4; P, 0.2 to 0.3; and S, about 0.03 per cent.

About 0.8 per cent. to 1 per cent. of silicon are added with the charge in the form of ferro-silicon, while the necessary balance of silicon and manganese are fed into the bath in the liquid state by means of an auxiliary apparatus heated by the hot gases from the melting zone of the furnace. The fuel used is a good Westphalian foundry coke in large pieces, which is coated by immersing it in lime sludge, thus making its reaction sluggish.

The proportion of the heating coke, etc., is the same in the "C" and the "N" methods, the maximum of charge coke being 10 per cent. The limestone added is about the same in each case. The blast volume is from 1½ to two times as great in "C" as it is in "N," the result of which is a loss, by oxidation, of 30 per cent. to 35 per cent. of the silicon and manganese introduced through the shaft. Since, however, half of the silicon and the major portion of the manganese avoids the oxidising zone and reaches the iron bath via the auxiliary reducing melting apparatus, the total silicon loss is about 15 per cent., to 20 per cent., and the manganese loss about 10 per cent. to 15 per cent., that is to say, is no higher than the normal. The most important, and the deliberate result of the intensified blowing is that the large amount of carbon usually absorbed by the molten metal from the coke used for melting is reduced. The metallurgical processes involved are, of course, not easy to establish. It may be supposed that the drops of iron trickling down are not con-

* Paper read before the Austrian Section of the German Society of Ironfounders at their meeting. It has been translated by the B.C.I.R.A.

† Presumably carbon was burnt out of the metal.

verted to a higher stage of carburisation, and that because of the increased blast volume and the clay-coated coke. Also any higher carburisation present in the iron drops is at once partially resolved by the increased blast volume.

Under normal working conditions, the intense blast would render the whole of the furnace shaft white hot and detrimentally affect the melting process. Due to the coke being sluggish in reacting, however, any "top fire" in the furnace is eliminated, as the coke prevents the dissociation

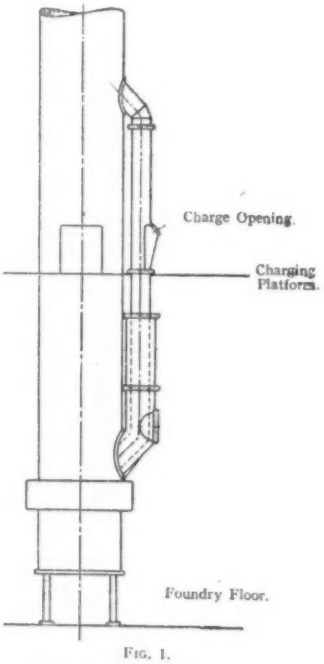

FIG. 1.
AUXILIARY MELTING APPARATUS FOR NON-RECEIVER CUPOLAS.

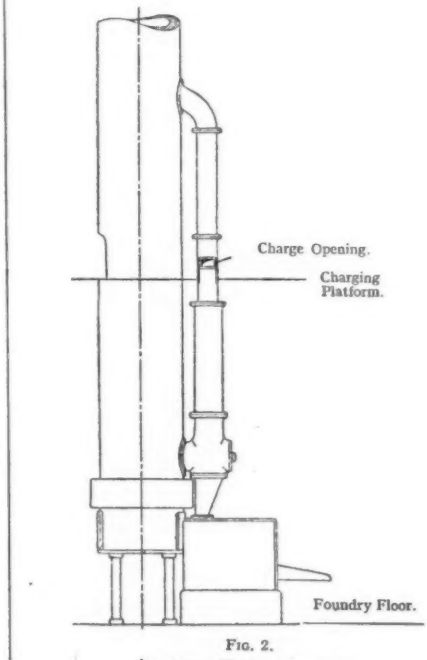

FIG. 2.
AUXILIARY MELTING APPARATUS FOR RECEIVER-TYPE CUPOLAS.

of the carbon dioxide which usually occurs. The gases issuing from the throat have an average temperature of 250 deg. C., *i.e.*, they remain within tolerable limits. Whereas the operation of "coating" the coke causes no considerable modifications in normal heats, it has a specially beneficial effect in the "C" process, preventing or greatly limiting the amount of sulphur given off to the iron. Thus in the "C" product the sulphur content is very rarely above 0.12 per cent. The very important "iron loss" thus remains within tolerable limits. The percentage of ferrous oxide in the slag, viz., about 14 per cent. to 16 per cent. FeO, is certainly higher than in "N" melts, but the actual iron loss is insignificant.

As regards the properties of the material, in view of the low total carbon, it approximates to a uniform analysis. Although the grain is not entirely uniform in light and heavy castings, there is not the remotest suggestion of the difference found in normal working with the same charges. The texture is never coarse crystalline at all. The texture of sand-cast castings exhibits a pearlitic crystallisation structure, with the graphite well distributed.

Casting Properties.

"C" iron is very hot when it leaves the furnace, at, say, 1,480 deg. C. to 1,500 deg. C. It must, of course, be cast hotter than "N" iron, owing to its low carbon content, and the more so as one is dealing with a very low phosphorus material. For light castings it will be advisable to raise the phosphorus content to between 0.5 and 0.6 per cent. by means of ferro-phosphorus, and experience with the electric furnace shows that this does not impair the strength properties. If also the sulphur is reduced in the recognised manner even the lightest (thinnest-walled) castings can be made with this material.

The "C" process can also be used in malleable castings. It is clear that the malleablising process can be carried out better and quicker where the total carbon content is low and the graphite in a fine state of division. Tests have shown that even a 24 hours' annealing renders the low-carbon product malleable. Emmel found the same thing when experimenting with his low carburised cast iron; though only at the beginning of a development the results so far obtained give great expectations. Most malleable iron founders have a high coke consumption in their melting operations. Osann, in his text-book, mentions examples of up to 40 per cent. The fact is that when melting down greater or lesser proportions of added steel, a large charge of coke is necessary, whereas, as already stated, the "C" process calls for no more than 10 per cent.

The auxiliary melting apparatus is nothing more than a pipe passing from the melting zone and terminating in the chimney stack (Fig. 1).

TABLE I.—*Analyses and Strength Properties of Cupola Cast Iron made by the Corsalli Process.*

Sample.	C. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Transverse. Tons per sq. in.	Deflection. in.	Tensile. Tons per sq. in.
1	2.82	2.07	1.33	0.26	0.111	40.3	0.38	22.51
2	2.71	2.21	1.23	0.24	0.111	37.8	0.35	22.31
3	2.64	2.00	1.40	0.28	0.108	36.87	0.45	21.87
4	2.69	2.35	1.45	0.25	0.120	36.51	0.38	24.61
5	2.79	2.21	1.30	0.26	0.110	36.58	0.35	24.11
6	2.71	2.35	1.30	0.28	0.119	34.33	0.40	22.61
7	2.65	2.44	1.36	0.26	0.100	35.84	0.38	23.48
8	2.81	1.97	1.32	0.24	0.090	41.12	0.41	24.85

The lower part is lined with refractory material or bricked. The charge opening is on the charging platform, and it is advisable, after introducing the charge, to close it with a flap valve. The additions are made at intervals according to the throat charge in the cupola, and the pieces used should preferably be large, say the size of a man's fist. A small admixture of coarse pieces of charcoal, especially where the added material is in small pieces, is necesary, to prevent covering up the flame which projects through a narrow slit and into the apparatus with a temperature of above 1,600 deg. C. Melting takes place rapidly. When the normal charge through the throat is finished, and when the charges have settled down, it is well to put a shovelful of sand in the apparatus, as this prevents it becoming fouled up by the slag and coke that are thrown up.

In the case of cupola furnaces fitted with a receiver, and which should certainly be preferred when working with the "C" process, the auxiliary melting apparatus is arranged as shown in Fig. 2. The liquid material does not flow through the same opening through which the hot gases pass, but the melt flows through a slit in the receiver, that is to say, directly on to the iron jet running out of the shaft, and from which the slag is kept back by means of a syphon.

The difficulties connected with the introduction of ferro-alloys are well known. Whether the material is introduced through the shaft, into the spout of the furnace, or is added to the ladle, only a fraction of the added material was found incorporated in the iron. Even where the alloy constituents are added directly into the receiver there is no certainty of success, but it is known that the molten iron is cooled down, and that is just what must be prevented.

With the Corsalli auxiliary apparatus one is enabled to try out whether the advantages, so highly praised by the Americans, of additions of vanadium, molybdenum, and other alloy constituents, still further improve the properties of cast iron. It will now be possible to produce in the cupola a heat-resisting cast iron by adding chromium to the metal, while the full-scale production of highly silicised cast iron for the chemical industry becomes possible.

The extent to which the pig-iron producers endeavoured to save the ironfounder as far as possible from using an iron with too low a carbon content is evident from an interesting paper by Bronn in "Stahl und Eisen," No. 26, p. 881, of June 30, 1921, in which an account is given of attempts made by a large blast-furnace works during the war to produce high-grade synthetic foundry pig-iron. The writer states: "In basic open-hearth ingot iron of the usual composition there is a source of iron which, as regards its phosphorus and sulphur content (usually about 0.08 per cent. P and 0.04 per cent. S), that is to say, in regard to 'purity,' approximates very closely to the best foundry types. Any desired proportions of manganese and silicon may be incorporated without much difficulty by means of suitable ferro-alloys. The question in the final analysis, then, is this: whether there are ways and means of alloying safely and economically with iron larger quantities of carbon—*i.e.*, up to 3 per cent. and even 4 per cent." After stating that this end can be attained by introducing liquid iron saturated with carbon into the bath as refined in the open-hearth furnace, mention was made of the fact that carburisation of the iron was effected by dissolving ground electrode carbon, with the addition of some lime, in an electric furnace that was fed with liquid basic ingot iron. Since production in this way was too low, another method of production had to be sought.

Bronn further states: "From prevailing ideas regarding the blast-furnace process, it is assumed that the drops and particles of iron reduced from the iron ore dissolve carbon when flowing down through the incandescent column of coke, and so become saturated with carbon. The effect is similar when ingot scrap iron is melted in the cupola. In order to clear up this point a large series of melts were made in an ordinary foundry cupola lined out with radial bricks to a diameter of 37 in. The furnace was filled with coke to 8 in. above the tuyeres with two metric tons of coke and operated with 18 per cent. charge coke."

After, to a certain extent, achieving the purpose aimed at in this way, the next thing is to put liquid ingot iron directly through the shaft of the cupola filled with coke, or coke and charcoal mixed. Thus, while the well-meaning blast-furnace man does his best to see that there is carbon in the foundryman's iron, the foundryman is all the time wondering how he can get it out again.

It is a recognised fact that the life of iron deteriorates when the carbon content is lower than 2.4 per cent. And it is known—at least provisionally—there is no suitable means for altering this state of things. First of all, then, the ironfounder has no interest in aiming at a lower carbon content than that mentioned. But in order just to get this carbon content he uses an initial material low in carbon, and, for want of something better, uses steel and wrought-iron scrap. Despite the satisfactory results obtained by this method the ironfounder cannot regard this as the ideal material. Steel scrap has the great advantage that its price, in North Germany at any rate, is approximately half that of pig-iron, but this advantage will disappear to the extent to which the ironfounder uses steel scrap. For the time being, therefore, foundrymen must make their wishes known to the producers of raw material, and since the blast-furnace man cannot fulfil them entirely they are quite right in considering the possibilities of the direct production of iron.

TABLE II.—*Influence of Added Steel on the Strength Properties of Cast Iron (from Geiger's "Handbuch der Eisen- und Stahl-giesserei").*

Added steel. Per cent.	Total carbon. Per cent.	Combined carbon. Per cent.	Graphite. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	S. Per cent.	Tensile Strength. Tons per sq. in.	Transverse Strength. Tons per sq. in.
0.0	3.63	0.51	3.12	1.76	0.53	0.488	0.062	10.00	19.50
12.5	3.37	0.53	2.94	1.76	0.57	0.515	0.139	12.00	22.20
25.0	2.95	0.51	2.44	1.83	0.55	0.610	0.100	16.36	26.30
0.0	3.94	0.54	3.40	2.35	0.56	0.515	0.061	9.80	17.60
25.0	3.16	0.60	2.56	2.53	0.54	0.490	0.104	14.80	23.38
25.0	3.23	1.08	2.15	2.36	0.24	0.327	0.064	14.00	25.69
0.0	3.81	0.63	3.18	1.96	0.44	0.446	0.104	9.70	17.86
12.5	3.36	1.06	2.30	2.16	0.20	0.315	0.060	11.70	21.44
37.5	3.40	0.57	2.83	1.97	0.48	0.470	0.093	14.45	24.41

Table I contains the results of a series of melts made by the "C" process. For comparison purposes Table II, taken from Geiger's handbook, is included.

Geiger writes in reference to these figures: "The tests confirm that, with increase in the added steel, the total carbon decreases, although to a limited extent, and the strength rises proportionately: 12½ per cent. of added steel raising the strength by about 25 per cent., and 25 per cent. of added steel giving 50 per cent. added strength. The best proportion of added steel for improving the strength properties seems to lie between 25 per cent. and 37½ per cent., since added steel in the latter proportion does not appear to cause any greater increase in strength than an addition of 25 per cent. does."

The enormous difference in the two processes is apparent. Stress should be laid upon the good machining properties of the "C" material, even at Brinell hardness numbers of 230 to 250. No hard spots occur in the castings such as might be feared when using fairly large quantities of (added) steel.

Direct Processes.

In this connection a large number of suggestions have been put forward in the last few years, as may be seen from the numerous reports published in "Stahl und Eisen." The problem of producing ingot iron or steel, as they did many centuries ago, directly from the ores without the intervention of the blast furnace is certainly attractive, especially as the technical auxiliaries available to-day are quite different from what they were then. It is not intended to give an account of the numerous processes that have been put forward with a view to solving this question of the economic production of iron direct from the ores, but Wüst states that up to 1921 there were 75 German patents granted in this connection. It is true that success has been obtained with a number of those processes, but it is not yet clear whether they are possible on an industrial scale. In view of the extensive progress made in indirect iron and steel production during the past few decades, it is inevitable that even the best of the direct processes will have to pass through many stages of development before it can compete with the ordinary processes that have now thoroughly proved themselves, much less surpass them, which, of course, would be the ultimate aim. Anyhow, ferrous metallurgists are showing great interest in the question of the direct production of iron and steel, with the idea, of course, of obtaining a finished product from the process. When it is learnt, for example, that in one of the numerous direct methods there is an intermediate product having a carbon content of 1.5 per cent., which must first of all be refined in a special furnace, then we can quite imagine the total process being too expensive. For the ironfounder, however, an intermediate product of this kind may in certain circumstances be the raw material he has been seeking. Foundrymen would be pleased to be supplied with an iron containing 1 per cent. to 2 per cent. of carbon, assuming, naturally, that the price of the material worked out better for them than the cost of adding the silicon and manganese by the method outlined above.

The main object of the above is to stimulate those concerned with the direct production of iron to make experiments from this standpoint. Very likely a special direct production plant would pay better if worked with this object in view than it would if worked with the express intention of producing a finished product. Everything points to the fact that the foundry engineers are doing their best to make up in developments for the time lost during and after the war. A series of new processes for improving cast iron have been made known. The opinion has often been expressed that the only way fundamentally to improve the qualities of cast iron is by evolving a new type of furnace. It is a matter for great satisfaction that it has not been possible to supplant the old cupola furnace, and that it will maintain its leading position in ironfounding. It was necessary, of course, to observe and check the performance of this furnace, and, in view of its own peculiar character, to deal with it more strictly than before, and it is left to others to decide whether it is sufficient simply to "shake and jog it" at each operation.

The Refractories Association of Great Britain.

At a meeting held in Sheffield on December 8, Mr. H. Winterton gave a Paper entitled "My Tour in America and Canada."

It was one of the most enjoyable trips I have ever taken to the States. Although I am not a teetotaler, I could not resist the impression that prohibition had had a beneficial effect on the population of the United States as a whole.

I admit that illicit drinking has increased enormously since the "dry" regime has been in operation, and there is heavier drinking by the younger generation of the wealthier classes, but the great mass of the people could not obtain liquor. The general impression amongst all sections of the community was that prohibition had abolished the "saloon" evil and had come to stay.

To a stranger in the United States one thing would show up in bold relief, and that is the obvious desire of its citizens to impress on visitors the might and importance of their cities and more particularly the U.S.A.

Britons could with advantage study this point. A little less self-depreciation on our part and a little more outspoken pride in our country would impress our visitors more favourably.

Foundry Plants.

After leaving New York we moved on to Philadelphia, where the Sesqui-Centennial Exhibition of the United States was being held. The delegates attended several foundry plants in the neighbourhood, including those of the Westinghouse Pump and Baldwins, where some very smart appliances and equipment for labour saving were seen.

From Philadelphia to Buffalo we visited the Niagara Falls and thence to Detroit, where the Foundrymen's Convention was to be held. About 6,000 foundrymen, recruited from nearly every nation in the world concerned with foundry practice, were in attendance.

The organisation of the Convention and its exhibition was indeed wonderful. Machinery and materials used by foundrymen were shown in every variety. So far as sand is concerned, the people who sell British sand have nothing to fear by comparison with the sands used in America.

In foundry practice generally in America, they might be ahead of us in respect of repetitive work and machine moulding, but so far as jobbing work is concerned, they are well behind the old country.

The difficulty in getting young men to learn the work is much more accentuated in the United States than in Britain—in fact, the majority of men who hold the best jobs in American foundries are either of British origin or trained in Britain.

Leaving the United States, we crossed the frontier into Canada, calling at Toronto, Ottawa, Montreal, Quebec, and several other places.

I was greatly impressed with the progress which the Canadians are making in their industries and big cities. The comparison between the present time and when I first saw Canada 25 years ago, was indeed astonishing.

British Trade.

It is the result of my visit to Canada that I wish to convey a message to British manufacturers. Three things stood out clearly in my mind. The first is that Canada will never of its own volition become part of the U.S.A. Between those two countries there is an impassable gulf in ideals and characteristics which will never be bridged. Secondly, more people who are willing to work are required there; and, thirdly, the Canadian business men want more British trade. They would rather pay slightly enhanced prices for British goods than buy American or other foreign products.

The reasons which prompted this attitude were twofold. Firstly, because British quality stood out in the minds of everyone on the American Continent representing the highest in the world, and therefore more reliable; secondly, a much larger degree of sentiment and loyalty, than we are prone to credit them with, exists in Canada.

A Field for Inquiry.

Negotiations are now proceeding for the sale of land to British manufacturers who wish to erect plant in Canada with the object of supplying that market.

Canadian foundrymen are using a lot of American refractories which they would rather be without, but in the absence of any other they are compelled to adopt that course.

Here surely is a field for inquiry and research by British refractorers. Any British manufacturer who thinks fit to investigate the Canadian market conditions will receive every support, help and sympathy from our people there, for they are anxious for us to go over and try.

THE DIRECTORS of the Falkirk Iron Company, Limited, have declared an interim dividend of 5 per cent., actual, less tax, on the ordinary shares.

A Sceptic in the Iron Foundry.

By A. Allison.

The literature of cast iron is full of statements by quite serious, thoughtful foundrymen which give a shock to those with some knowledge of chemistry and physics. Many of the statements virtually invite us to throw overboard the chemical and physical laws which represent the cumulative effort of generations of men to understand the properties of matter.

The scientific man must approach the practical founder with great caution. As Professor Arnold used to teach his students at the University of Sheffield, the young scientific man must be very

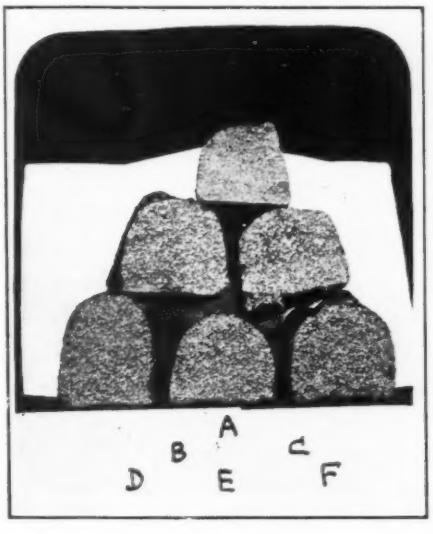

FIG. I.

careful not to despise the observations accumulated by the practical man over many years.

At the same time, cast iron would indeed be a deep and dark mystery if one attempted to arrange the statements made by foundrymen into one harmonious whole. Such statements have been made largely upon the old question of the relation of fracture to strength and chill. It is alleged that an iron with open fracture always preserves open fracture after re-melting. The analyses given at the same time show a silicon content of 2.5 per cent., which is sufficient to ensure an open fracture every time without invoking some mysterious law of heredity. The most open fracture seen by the writer is in an iron with silicon 3.5 and phosphorus 1.5 per cent.

with fairly steady conditions, fracture was a rough guide to the composition and properties of the iron, but for some years this has not been the case. Iron smelters, for economic reasons, have had to deal with ores from any suitable source, and work their plants more intensively, so that composition of the metal and cooling conditions

TABLE II.

	C.	Si.	Mn.	S.	P.
Hematite	—	2.54	0.94	0.025	0.039
	—	3.48	0.92	—	—
	—	2.76	1.88	0.044	0.026
	—	1.34	0.79	—	—
	—	0.83	0.94	—	—
	—	1.02	0.91	—	—
	—	2.34	1.19	—	—
	—	2.37	1.16	—	—
Cheap foundry iron.	3.71	3.92	1.43	—	1.050
	—	2.43	0.93	—	1.110
	—	3.60	0.88	0.030	1.510
	—	3.64	0.90	0.028	1.440
	—	1.65	0.33	0.114	1.540
	—	1.61	0.38	0.122	1.570
	—	2.18	0.40	0.030	1.250
	—	2.29	0.50	0.054	1.210
Better foundry iron.	3.66	2.35	1.04	—	0.820
	—	3.85	1.22	—	0.970
	—	—	1.16	—	0.750
	3.59	3.27	1.25	0.026	0.420
	3.56	3.07	1.17	0.024	0.680
	—	2.94	1.16	0.076	0.840
Cold blast iron	3.43	0.55	0.60	0.116	0.300
	—	0.57	0.60	0.108	0.350
	3.00	0.71	0.66	0.136	—
	3.16	0.64	0.67	0.192	—
	—	0.43	0.53	0.120	0.423
	—	0.48	0.68	0.176	0.410
Swedish.	—	0.75	0.69	0.011	0.095
	—	0.90	0.80	0.012	0.097
	3.93	1.12	0.63	0.012	0.100
	—	1.31	0.71	—	—
	4.15	0.87	0.74	0.010	0.100
	3.90	0.67	0.55	0.016	0.100
	—	0.87	0.81	0.006	—
	—	0.83	0.82	0.004	—
	—	1.23	0.80	0.016	—
	—	0.90	0.59	0.011	—

have altogether upset the fracture test as a guide to the properties of the metal. For the same reason difficulty in breaking the pigs is not a particularly good indication of what the metal will be after re-melting, as shown by Table I.

The writer has found the following rules to represent pig-iron fairly well:—Hematite iron means iron smelted from any kind of ore whatsoever, imported or otherwise, giving high silicon, possibly high manganese, and low sulphur and

TABLE I.

	C.	Si.	Mn.	S.	P.	
Cold Blast Iron ..	3.41	0.55	0.60	0.116	0.30	Moderately difficult to break.
" " ..	3.16	0.64	0.67	0.192	—	" " "
Hot Blast Iron ..	—	0.66	0.95	0.065	0.046	Much more difficult.
" " ..	—	1.00	1.65	0.036	0.045	Less difficult.
Stock melt	3.36	0.90	0.53	0.092	0.210	Very difficult to break.
"	3.57	0.84	0.51	0.050	0.135	" "

On the other hand, a close-grained iron generally has a silicon under 1.6 per cent. with a low manganese, and this again is sufficient to give a close-grained iron on re-melting. Fig. I illustrates fractures found in commercial iron. "A" is a cheap iron with high phosphorus, but manganese only 0.4 per cent.; "C" a similar iron, but higher silicon and high manganese; "B" is a better iron with high silicon and manganese and medium phosphorus, and "D," "E" and "F" are hematite irons, "D" having manganese 1.7 per cent. What these will be on re-melting will be considered later.

What Happens at the Blast Furnace.

It would seem that in past years, with blast furnaces working on the same ore regularly and phosphorus; in fact, an iron suitable for acid steel-making processes. Cheap foundry iron means iron with high silicon and high phosphorus, fairly high manganese and low sulphur. More expensive foundry irons contain medium silicon and phosphorus. Cold blast irons contain low carbon, silicon and manganese, but high sulphur. Silicon and manganese seem to expel sulphur from the iron in the blast furnace, the manganese by slagging off and the silicon by preventing solution.

Table II well illustrates these points. In each case the analyses bracketed together are two separate pigs from one lot. It is obvious that to melt mixtures of these without allowing for averages might on the whole give fairly steady compositions, one balancing another, but there must be

wide variations when, on the one hand, high silicon irons fall in the same mix, and, on the other hand, low silicon irons are charged together.

Whilst considering the value and importance of analysis, it is suggested that frequently it is worth while to search for copper, chromium, titanium and vanadium. Copper does not appear to affect iron very much, but a small quantity of chromium is very powerful in its effect.

Titanium undoubtedly has some effect in shielding the metal from the effect of gases, and if 0.1 per cent. vanadium makes a marked difference to steel, how much greater must be the difference in a rich alloy like cast iron? Is it not likely that widely differing results from mixtures of apparently similar analysis might be accounted for by the presence of one or other of the above elements so frequently overlooked?

The following are some results obtained:—

	Cu.	Cr.	Ti.	Va.
Hematite Iron ..	0.083	0.266	—	—
	0.102	0.239	—	—
	0.172	0.370	—	—
Foundry iron ..	—	—	0.225	—
	—	—	0.259	—
Casting	—	—	0.090	0.03

The better foundry irons seem to be higher priced because of lower phosphorus, but it will be seen that the difference is not so very great. In view of the variations of composition of even small parcels of pig-iron, the analysis supplied by the maker is a very rough indication. Hence the only way of proving an iron is to take a sample truck, analyse two or more separate pigs, and working by analysis, try a melt or two.

Economy does not as a rule permit of making stock melts for ordinary casting work, but when possible this is a useful method of averaging scrap and pig and obtaining a metal which will respond to analysis and other tests.

What Happens at the Foundry.

The cupola is the cheapest known method of melting metal, but it is at best a clumsy tool. Many confusing variations of product arise from the variations of cupola conditions, viz., blast pressure and volume, atmospheric moisture, lack of uniformity of coke, additions of limestone, size of scrap, and method of charging. The current varies at the motor for the fan, and atmospheric moisture is out of control, so that every cupola should have a pressure and volume meter. Although expensive at first, the exact conditions suitable would be quickly arrived at by experiment, and better melting obtained at less cost.

It is now understood that the quality of cast iron turns largely upon the total carbon contents and its condition, and in this connection the following figures are illustrative. Analyses of routine cast irons made from various mixtures gave results varying at random from 3.4 to 3.75 per cent. total carbon. An attempt to produce a low-carbon iron by melting a mixture containing steel scrap, and calculated to give 3.1 per cent., produced an iron with the routine figure of 3.41 per cent. A spoon test was taken by inserting a spoon hammered out on the end of a long bar through the tuyere hole. This gave a total carbon of 3.36 per cent. It is clear that in the melting zone considerable oxidisation takes place in a kind of handicap, which is quite general to all ferrous melting operations. Manganese loses 35 per cent. and silicon loses about 12 per cent. or more. Notwithstanding the keen affinity of manganese and silicon for oxygen, the carbon also suffers oxidation. In the hearth of the cupola the liquid metal as it accumulates must push the coke upwards and carry the burden of coke up to the tuyere level. After each tap hot coke drops down to the hearth and is pushed up again by the gathering metal. Hence, although carbon is oxidised in the melting zone, the iron has every opportunity of dissolving carbon (and sulphur), according to the nature of the coke, time and temperature, etc.

These variables account for the varying carbon contents in the iron. Probably all cast iron would be better with a total carbon content of 3.2 per cent. or less, but some other means will have to be employed to realise this, such as an oil- or gas-fired hearth furnace acting as a metal mixer, or receiver, secondary to the cupola. Carbon in steel is vital and controllable; in cast iron it is somewhat of a nuisance from the difficulty of controlling it. Hence cast iron, which, after all, is steel mixed up with graphite, calls for much greater care in control if higher quality is to be attained.

It must also be remembered that in adding steel, whether liquid or solid, to reduce the percentage of total carbon, that other elements are equally diluted and call for corresponding allowances. Similarly, if the mixing be performed in some kind of a hearth furnace, there is further slight oxidation by flame and slag. Frequently also the temperature of casting is variable; it may range from 1,190 to 1,300 deg. C., or higher, so that conclusions should not be drawn without all the evidence being brought into consideration.

Many other perplexities in connection with cast iron are explicable by the ordinary rules of chemistry and physics. The suggestion that graphite in iron which has been smelted hot has some peculiar property causing precipitation in the re-melted iron may be examined thus. How did the iron originally acquire its carbon contents in the blast furnace? By solution from carbonaceous matter, solid or gaseous. Is it conceivable that the graphite thrown out of solution on cooling should not equally well re-dissolve when the metal is re-melted?

There seems to be an idea held in certain quarters that cast iron can be melted without all its constituents being dissolved homogeneously in the liquid metal. In the hearth of the cupola any unmelted portion has every opportunity of floating to the top, and the method of tapping is such that any separated portion would still remain on top in the ladle.

That iron becomes whiter on re-melting, and sometimes loses quality by repeated re-meltings, is fairly well explained by silicon and manganese losses. Thus:—

	Si.	Mn.
	Per cent.	Per cent.
Pig-iron	1.00	1.70
First re-melting	0.82	1.30
Second ,, ...	0.64	0.77

Taking the average of foundry scrap as 2 per cent. silicon and 0.5 per cent. manganese, we should get the following results:—

	Si.	Mn.
	Per cent.	Per cent.
Scrap	2.00	0.50
First re-melting	1.75	0.30
Second ,, ...	1.50	0.18

This last manganese is too low to give a sound iron, and some irons are too low in manganese already to stand melting more than once.

Similarly the iron "A" shown in Fig. I, having only 0.4 per cent., will require mixing with a higher manganese iron, say B or C, which contains 1 per cent. One virtue of using hematite such as E and F is that the manganese, being 1 per cent. or over, is a corrective.

The practical founder by his experience tries out each class of material and arrives at his results with surprising success on the whole. One cannot but feel, however, that if each material were carefully analysed and mixed accordingly, and the strength of the product accurately measured on the testing machine, good quality would be regularly arrived at more cheaply, taking into account the necessary trial castings and melts.

It is very important in considering results, whether of fractures, chill tests, transverse, tensile or other tests, that analysis, casting temperature and rate of cooling according to the thickness of section and temperature of the mould should be observed upon the actual piece concerned. In other words, that deductions should only be drawn after all the factors, both chemical and physical, which may affect the casting have been taken into account. Only in this way can we hope to build up the knowledge of cast iron into a concordant and harmonious whole.

The American Steel Foundry Industry.*

By R. A. Bull, Chicago.

Probably the original steel castings made in the United States were produced in what was known as the William Butcher Steel Works, which later came under the control of the Midvale organisation. Among the first steel castings made at the Butcher foundry were crossing frogs for the Philadelphia and Reading railroad. It is claimed that these castings were so satisfactory that some of them were in use for 37 years, until 1894.

It is difficult to imagine a more fascinating story than the autobiography that might be written by John Hayes Hammond, dean of American mining engineers, now in his seventies, and continuing a highly useful career that has had many dramatic episodes. It will be a misfortune if Mr. Hammond eventually does not find the time and feel the urge to leave a written record of his life and observations, full of interest for all those who, in making their living in what some narrowly regard as industry, serve the human race by making the world a very pleasant place in which to live.

The steel foundry has had its pioneers whose experfences are of interest from many standpoints. Few of them have left chronicles of their activities. It is regrettable that old-timers now deceased, like Wharton, Johnson, Taylor, Eagan, Gallagher, Harrison, Deutcher, Geo. H. Smith, and others, were not generally of the type likely to sit down quietly in their placid days of ripened retrospection and record for those of a younger generation the events associated with the beginnings of the steel foundry industry in the United States. For, created sixty years ago, it has had a highly interesting development, largely dependent on concurrent progress in several industries, and essentially contributory to advancement in many. There are living, many individuals who have made during long careers, either through themselves or through the work of their subordinates, numerous important contributions to one or more phases of the steel foundry industry. Among these men are John Mahar, W. D. Sargent, J. C. Davis, I. W. Frank, C. C. Smith, S. P. Bush, W. H. Worrilow and C. H. Howard.

The purpose in referring to the earlier days and to the individuals who were prominent in the industry during significant periods of growth is to establish such relationship as may be helpful for intelligent consideration of present and prospective conditions.

Progress During the Nineteenth Century in Open-Hearth Foundries.

The history of the steel foundry industry in America for the first 20 years of its existence is not now of particular interest. Many manufacturing operations were then in a state of flux. Steel founders were cautiously feeling their way. The nation had not yet become an economic giant. Developments in the manufacture and distribution of steel castings were more or less sporadic until about 1887, when the successful production of steel rolls and certain castings for ordnance use directed the attention of many who foresaw the application of the product of the steel foundry to a large variety of uses. Before the last decade of the 19th century, the industry reached the adolescent stage and became an important factor in our country's economic development.

In the nineties, steel casting manufacture made an important advance step by the successful adaptation of green-sand moulding. Looking back and considering the striking effect this development had on the industry, it seems peculiar that information regarding green-sand moulding in the steel foundry was somewhat slow in coming to the notice of those in the technical world who betrayed interest in, while not associated with, steel casting manufacture.

Pioneers in the middle Western states were largely responsible for the development to which we are referring. Probably it was the principal factor in the very rapid adaptation of cast steel to railway use, which was to become extensive and permanent. Green-sand moulding did much to solve the problem of shrinkage, which had been an extremely troublesome factor in producing many castings, the designs of which presented difficulties with respect to the contraction of cast steel during solidification, excessive as compared with that of other ferrous metals. The result was among the most important epochs in the industry's development, through the establishment in the last few years of the 19th century, of large open-hearth shops for the specialised production of railway steel castings. There was economic justification for erecting these foundries, the number of which, and particularly the combined capacity of which, increased greatly during this period. In many respects, the 10-year interval beginning with 1895 can be regarded as of the highest importance in plant development for steel casting production. An innovation that was applied at this time with great advantage to many steel foundries was the use of fuel oil in open-hearth furnaces. This eliminated certain difficulties from red-shortness caused by sulphur from inferior coal used for producing gas. There were other advantages derived from the liquid fuel which have been of material benefit in many foundries.

Most of the railway specialty shops from the beginning adopted the basic lining for their furnaces, primarily because of the cheaper operating cost as compared with the expense of making acid steel, which continued to be favoured among the Eastern foundries, where the product consisted, to greater extent than in the West, of castings requiring extensive machining before application. In the nineties and at the beginning of the present century, there were restricted opportunities afforded the steel maker for satisfactorily deoxidising his metal. The result was a relatively large percentage of steel castings containing blow-holes, particularly in the product of the basic furnace, where the oxidation process is necessarily prolonged as compared with the operation of acid-lined furnaces. For some time the only alloy given the name of ferro-silicon which was commercially available, was one containing usually from 12 to 13 per cent. silicon. Carborundum or carbide of silicon was extensively used as a supplementary deoxidiser. It contained approximately 60 per cent. silicon, 35 per cent. carbon, 1.5 per cent. iron, and 1.5 per cent. aluminium. Restricted opportunities for uncontaminated deoxidisation naturally resulted in too great dependence on aluminium, which was introduced frequently in such a way as to materially reduce the shock resistance of steel castings.

Relatively poor ductility generally characterised steel as produced for castings at the beginning of the 20th century. The writer has records of the performance of a basic open-hearth foundry that in 1900 was well regarded, and produced common steel averaging 0.28 per cent. carbon, which, after a normalising treatment, showed usually a tensile strength of 31 tons and an elongation in 2 in. averaging 8 per cent. Such metal would not be acceptable to-day for most purposes employing cast steel.

The ductility values typical of acid open-hearth steel made at the close of the 19th century generally were higher by a small margin than those obtained in basic practice, but were far below the figures prescribed to-day. At that time, when steps were being taken to organise the American Society for Testing Materials, specifications for steel castings usually did not include requirements for reduction of area. The percentage of elongation was regarded by most engineers as sufficient indication of ductility. Engineering handbooks and copies of specifications published 30 years ago show a prescribed minimum tensile strength of 26 tons and a required percentage of elongation which did not exceed 15 per cent. and in many cases was as low as 10 per cent. Values

* Extracted from a Paper read before the Detroit Meeting of the American Foundrymen's Association.

for yield point and reduction of area were not prescribed. The progress of the industry during a quarter-century of development can to some extent be gauged by a comparison of the requirements just mentioned with those prevailing to-day, which provide for soft steel castings averaging at least 26 tons tensile strength, an elongation of not less than 24 per cent., and a reduction of area of at least 35 per cent.

The melters in charge of steel furnaces at the beginning of the present century and for some years thereafter were not responsible for all of the relatively poor showings of tensile test pieces, most of which met the easy requirements of earlier specifications. There was deficient knowledge of heat treatment, by which term is now generally meant normalising, annealing, or any other application of heat, single or repeated, for producing structural refinement. There was inadequate attention given to the accurate machining of test specimens, properly regarded to-day as a highly important factor. Tool marks on the finished throats of tensile test pieces were seen frequently, and often escaped criticism. It would be impossible intelligently to estimate what the tensile properties of cast steel as customarily made a quarter-century ago would have been, if skilfully heat-treated and tested. The melter's associates in the laboratory had much to learn regarding the procedures for developing by heat treatment the latent properties of the steel, and for evaluating the material by means of properly tested specimens.

Irrespective of the responsibility for comparatively poor results, it was ultimately recognised by intelligent consumers that they had not, during practically three decades, been supplied with steel castings whose homogeneity and ductility conferred on the product qualities making it sufficiently dependable under severe service conditions. Realisation of the necessity for improvement, at the time referred to, did not place steel castings in a conspicuously unsatisfactory classification as to serviceability. Practically every kind of iron or steel product was embraced in the all-inclusive category of material capable of being more skilfully manufactured, and of being tested with due regard for the characteristic properties of the product when made right. Steelmakers and users began to co-operate in the analysis of data regarding metal made under different conditions, about the time when the American Society for Testing Materials was chartered in 1902. Thus did the inauguration of standardised testing work give the steel-casting industry, like others, an invaluable stimulus that has prevailed without interruption, and will continue, without doubt.

It has been pointed out that the manufacture of steel castings in the United States reached the important stage of marked specialisation in the late nineties, through the erection of plants for producing steel castings in large quantities for railway use. Thus was provided the principal incentive for the construction of basic open-hearth foundries. Special equipment was installed about the same time in numerous shops to be largely devoted to the production of steel rolls and other large steel castings for mill use. The manufacture of rolls inevitably led to experiments with alloys, resulting during the next 10 years in the development of important combinations of the elements for this purpose.

Crucible Steel Foundries.

The crucible furnace, since 1899 the least important tonnage division of the industry, has maintained its production with reasonable regularity, considering the important developments with respect to other melting units. The earliest records showing steel casting production which are to-day considered reliable, do not extend beyond 1898. In that year the tonnage of crucible steel casting exceeded the output of the production from the converter, and was more than 4,000 tons. Ten years later it had practically doubled. The peak was reached in 1912, when slightly more than 20,000 tons were produced. The marked increase in the demand for small steel castings, which assumed a significant aspect about 1905, had its effect on crucible steel foundry production. By 1917 the tonnage of crucible steel castings roughly equalled the output 18 years before that time, after a fairly steady decline that began in 1913 and resulted in the very low output of 736 gross tons in 1921. Last year the tonnage of crucible steel castings was reported as 1,833, or less than 10 per cent. of the production 14 years before, when the peak for this branch of the industry was attained.

It has been shown that a relatively small volume of steel castings has been produced in the crucible furnace. The size of the vessel militated greatly against its extensive application. The cost and short life of the crucible presented serious handicaps. The converter, despite its very high melting loss (including cupola) of approximately 15 per cent., proved to be a less expensive operating unit than was the crucible furnace. Important features of the converter were its fair-sized capacity, and frequent delivery of the finished metal. This vessel has never had an equal from the standpoint of supplying the moulding floor with steel in moderate or large quantities at a rate approaching continuous performance.

Converter Steel Foundries.

A significant development began about 1905, through the adaptation of the Bessemer converter to the production of small steel castings, previously made in relatively low tonnages. The principal inventor responsible for the modification of the converter was Tropenas, whose experiments in Europe in 1890, in blowing the metal above its surface met with success. The converter, modified as to size and partially as to operation, proved to be one of the most useful devices developed for making steel castings. It solved very satisfactorily the problem of high temperature, which had been a difficult one for open-hearth foundries producing heats usually ranging from 15 to 25 tons, limited as to practicability of high temperatures by the life of refractories, and by construction details that necessitated long periods of shutdown for renewing refractories. Ultimately the applicability of the open-hearth furnace to small steel castings manufacture was aided by the construction of melting units having a capacity as low as five tons, and having regenerative chambers and stacks very liberally proportioned to facilitate the utilisation of higher temperatures than were typical of open-hearth furnaces of customary foundry sizes. However, the open-hearth furnace in its essential details was recognised from several standpoints as poorly adapted to the specialised production of small steel castings. The converter took its temporarily commanding position in the industry for that purpose, and maintained it until the development of the electric furnace.

The temperatures possible to obtain in the converter provided metal sufficiently fluid to run the smallest sections preferred by designers of very small parts. Shops employing this melting medium, while in a fortunate condition with regard to the specialised production of small steel castings, found themselves handicapped by high metal cost in competition against open-hearth foundries, when producing castings of heavy weight or large sections. In this, as in all other similar cases, the melting medium occasionally was used for work to which it was not adapted economically. It began to be apparent that the industry, by the nature of the product, would divide itself eventually into two sections. At times there has been a disposition to minimise the distinct separation of the industry, according to the production of large and small steel castings. Confusion has resulted from the occasional, uneconomical adaptation of fairly large open-hearth furnaces to the manufacture of very small castings; and the intermittent, costly use of converters and electric furnaces of small capacity, in the production of very large castings. The industry satisfactorily splits itself into the two divisions according to the melting equipment utilised by the foundry, irrespective of the proportions of castings wisely or unwisely made.

During the first decade of the present century, the manufacture of small steel castings by the aid of the converter made many inroads on the business previously enjoyed by malleable iron founders; and by the development of new uses for steel castings where the strength of the material

was an important factor in connection with preferred lightness of section. Many of these new uses were such as to require, for the sake of appearance, surfaces much smoother and freer from blemishes than were required on castings of moderate and large sizes. This naturally resulted in the specialised development of cleaning equipment for small steel castings. Thus did the ingenuity of the mechanical engineer follow that displayed by the metallurgist. That vital relationship has prevailed.

The successful production of converter steel castings inaugurated applications of the product in a great many important industries. The converter proved itself to be, when properly regarded, not a competitor of the open-hearth furnace, but a very important auxiliary to it for steel casting production. The annual output of converter steel castings increased from less than 4,000 gross tons per year in 1899 to more than 22,000 tons in 1905. By 1910 the tonnage of converter steel castings had grown to a figure slightly under 60,000 tons; and the peak of converter steel casting production was attained in 1918, when more than 160,000 tons were credited to this branch of the industry. A reduction in output then began, due to the increased popularity of the electric furnace, to be referred to below.

Electric Steel Foundries.

Thirty years ago a scientifically trained major in the Italian army chose a location in the Alps for exhaustive experiments to demonstrate his faith in the theories held for many years by eminent scientists, that the electric current could be made a satisfactory source of heat for melting and refining steel. Major Stassano's success in 1899 immediately drew the attention of other experimenters in Europe to this method of making steel. Progress in developing the electric steel furnace was for several years pronounced in France, Italy, Germany, Norway and Sweden. English steelmakers did not find themselves in a particularly advantageous position with respect to this development because of the topography of their country and the resulting scarcity of water-power.

It was almost ten years after the electric furnace was demonstrated by Stassano to be commercially a successful method of steel manufacture, when metallurgists began their first experiments with it in America. The United States Steel Corporation had prior to this sent its investigators to Europe to study the operation of electric furnaces, of both the arc and induction types.

The pioneers in making electric steel in this country, mentioned in consecutive order, were the Halcomb Steel Company, the Firth-Sterling Steel Company, the General Electric Company, and the United States Steel Corporation. The first two of these started making electric steel commercially in 1908. It was not long after the announcement of the regular production of electric steel for the fabrication of parts not made in the foundry, when certain steel foundries who specialised in small work began to study the adaptability of the new unit to their plant operations. The high installation cost was a factor that made steel foundrymen proceed slowly. An important element of expense in numerous localities then, as in some localities now, was the difficulty of obtaining sufficient electric power at a reasonably low rate. The first steel casting plant selling its product to other industries, which installed an electric steel furnace, was the Lebanon Steel Foundry, where the regular production of electric steel castings for miscellaneous purposes began in 1912.

As previously explained, there was about this time (1910) a quickened demand for small steel castings. This had materially increased the combined capacity of steel casting plants employing converters. Within three years the output of castings from converters had leaped from a little more than 20,000 to nearly 60,000 gross tons. Meanwhile, largely for their own use, some of the steel companies that had installed the electric furnace primarily for rolled or forged products, began to make a few steel castings. In the year 1908 there are said to have been 55 tons of castings thus produced in this country, and during the following year, approximately 300 tons. By 1912 the output of electric steel castings had grown to more than 4,000 tons, and in 1913 it had reached the figure of 9,200 tons, then amounting to slightly less than 1 per cent. of the output of all-steel castings produced in the United States.

Without doubt the capacity of the electric branch of the steel-foundry industry, during a few years, starting with 1910, was greatly increased by the lively imagination of certain exploiters of the new melting medium, who unwisely but successfully undertook to sell many foundrymen with the idea that the electric furnace is admirably adapted to the manufacture of any kind of steel casting within the weight limit regulated by hearth capacity. Some of these enthusiasts vigorously proclaimed what they might have thought, but what was not, and is not, true, viz., that electric furnaces can satisfactorily produce steel with less attention than is required for the operation of converters or open-hearth furnaces. Apparently a few foundrymen have adhered to these mistaken ideas. A producer of steel castings, at the 1925 convention of the American Foundrymen's Association, stated that less skill is needed for operating the electric steel furnace as compared with the open-hearth or converter. Inquiry should be made regarding the uniformity, ductility, and other characteristics of steel produced, before acceptance of claims that within a few weeks a reasonably intelligent man who never previously made steel can be graduated as a good electric steel melter. It should be kept in mind that there are good, bad, and indifferent grades of metal produced from every kind of steel furnace in use; and that no process is foolproof, nor capable of satisfactorily functioning according to high standards without skilled manipulation.

Alloy Steel Castings.

It has been mentioned that the increasing manufacture of rolls during the late nineties led to experiments with alloys, which resulted in the development of important combinations of the elements for that special purpose. The discovery of manganese steel by Sir Robert Hadfield, in 1888, was followed, four years later, by the manufacture of the first manganese steel castings in the United States at the plant now owned by the Taylor-Wharton Iron & Steel Company at High Bridge, New Jersey. This development was without doubt the most important one related to alloy steels that characterised steel foundry operations during the 19th century in this country. The manufacture of manganese steel became a specialised branch of the industry, and the product was found to have superior properties for a number of uses to which carbon steel was poorly adapted.

Manganese steel has been made in crucible furnaces, converters, open-hearth furnaces and electric furnaces. The last are used for making most of the manganese steel castings now produced.

The study of the performance of steel containing from 13 per cent. to 15 per cent. manganese, commonly classed as manganese steel, developed the fact that this material was not best suited to some purposes for which carbon steel had been employed unsatisfactorily. This prompted experiments with varying percentages of manganese above the content used ordinarily in the steel foundry but below the amount in what had been called manganese steel. The result was the development, due mostly to John Howe Hall, of a very useful group of simple alloys, highly susceptible to scientific heat treatment. These became favourably known about 1915.

At the present time experiments are being made to produce alloy steels for castings to withstand very high temperatures and pressures simultaneously and continuously applied in service. This presents the most difficult problem steel foundrymen have been asked by industry to solve.

Organised Co-operation.

The American Society for Testing Materials was the first national organisation to stimulate the steel founder in improving his shop practices, through the co-operative investigation of testing methods, which began in 1900. The American

Foundrymen's Association, organised in 1896, failed to draw the serious attention of steel foundrymen as a class to its opportunities for advancing their industry, until about 1911. Interest manifested at that time in the presentation of papers on steel foundry topics prompted a movement on the part of progressive manufacturers of steel castings to utilise the A.F.A. as the logical medium for the interchange of experiences and for the discussion of theories relating to the technical phases of the industry. Without doubt the A.F.A. has been the most effective means for developing co-operation between steel founders, through cordial relationships established between operating executives of competing organisations. Approximately 200 steel foundries are at this time affiliated by membership in the A.F.A.

Other organisations and institutions whose activities have national significance, which have been helpful in one or more ways to steel foundrymen, include the following: American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, Society of Automotive Engineers, American Electrochemical Society, American Society for Steel Treating, American Welding Society, American Iron and Steel Institute, National Research Council, U.S. Bureau of Standards, U.S. Bureau of Mines, and the U.S. Division of Simplified Practice.

In thus giving credit to national organisations and government departments for the assistance they have rendered the steel-foundry industry, it is appropriate to mention the benefit derived by American steel founders from the activities of the Iron and Steel Institute chartered in Great Britain, but having a membership of international character.

It is no longer necessary to emphasise to steel foundrymen the benefits from co-operation. Probably the future will see numerous collective efforts by competitive manufacturing plants, each such instance of co-operation being intensive, and characterised by a relatively small number of participants, employing substantially the same major processes and making similar specialised products. Such smaller co-operative organisations promise to reflect the extent of specialisation in the industry.

Capacity and Output.

The steel foundry industry as a whole, without exception of any of its divisions or sub-divisions, was vigorously stimulated because of and during the world war. It so happened that previous to the war demands that followed the entry of the United States into the conflict, the production of steel castings was at a sluggish rate. This is illustrated by the total output of slightly more than a million tons of steel castings in 1913, followed the next year by a production of less than 700,000 tons. During each of the critical wartime years of 1916-17-18, the output of steel castings in this country remained fairly stable at a figure roughly averaging 1,400,000 gross tons. The peak of wartime production was reached in 1917 when 1,441,000 tons were made. To date the industry's record output exceeds that figure by a very small margin. The maximum demand of 1,458,000 tons was supplied in 1923.

The expansion of the steel foundry industry in America, caused by the war, proved to be uneconomical. Many foundries were built or enlarged. The expectation of obtaining, before the declaration of peace, a sound financial foundation for subsequent operations presented to some, such an alluring prospect that they gave inadequate consideration to the varying shrinkages of demand which would immediately follow the cessation of hostilities, which would attend industrial reconstruction, and which would characterise peace-times. To-day the chief handicap of the industry is the enormous combined capacity for producing steel castings, gauged with relation to the developed needs for the product.

Comparative data illustrating the point just made are obtainable from recently-published statistics. Within the last few months the American Iron and Steel Institute, following the careful accumulation of authentic first-hand information, published the latest edition of its Iron and Steel Works Directory. When the data is tabulated found in this book, which is the most reliable single source of information in self-estimated steel works capacity available, it reveals some very interesting facts. The yearly capacities of the various branches of the industry, expressed in gross tons of output, as summarised by the writer from the data in this publication, are as follows:—Acid open hearth, 939,607; basic open hearth, 909,385; *total open hearth*, 1,838,992; electric, 593,541; converter, 148,550; crucible, 3,730; and unclassified, 27,500 tons.

These figures show a combined annual capacity of the steel-casting plants in the United States amounting to 2,622,000 gross tons—an enormous amount, much larger than indicated by any previously-published statistics.

A comparison of output with capacity is enlightening. The production of gross tons of steel castings in the United States in 1925 is reported by the American Iron and Steel Institute in its Special Statistical Bulletin No. 3, published June 12, 1926, to have been as follows:—Acid open hearth, 462,303; basic open hearth, 455,282; *total open hearth*, 917,585; electric, 279,534; converter, 53,834; crucible, 1,833; *total*, 1,252,786 tons.

When the figures listed above are reduced to percentages they become especially significant. It is found that the proportion of output to capacity of each classified branch of the industry in 1925 was as follows:—Acid open hearth, 49 per cent.; basic open hearth, 50 per cent.; total open hearth, 49 per cent.; electric, 47 per cent.; converter, 36 per cent.; and crucible, 49 per cent.

It is further found that the capacity of each branch of the industry calculated with relation to the combined capacity is as follows:—Acid open hearth, 36 per cent.; basic open hearth, 35 per cent.; total open hearth, 71 per cent.; electric, 23 per cent.; converter, 5.7 per cent.; and crucible, 0.14 per cent.

The percentages of the above correspond closely with those indicating the relative production in each of the three major divisions of the industry, as reported for 1925. Open-hearth castings, which in 1910 represented 90 per cent. of the entire output in the United States, last year amounted to 73 per cent. Electric castings in 1925 amounted to 22 per cent. of the combined production of the industry, having doubled in percentage in 7 years. Converter castings in 1925 represented a trifle more than 4 per cent. of the total output, having fallen more than 11 per cent. in eight years.

The industry has a capacity of more than 2,600,000 gross tons per year, and it produced in 1925 1,253,000 tons, or 48 per cent. of capacity. The largest output of steel castings in the United States of which there is a satisfactory record, was 1,458,000 tons in 1923, when war-time records were to slight extent exceeded. These statistics present the most conclusive proof of over-development, and should cause careful consideration by those who contemplate plant erection or addition. This means analysis of the extent to which each branch of the industry could supply its proportionate share of the total tonnage of steel castings used now and capable of being used economically in the future.

Unfortunately for some investors, steel foundries are not adaptable to other industrial purposes. Equipment for making steel castings, particularly those produced from metal made in open-hearth and electric furnaces, entails a large expenditure, and is difficult to remove to other localities. An electric or open-hearth steel casting plant maintains its industrial value only so long as it remains in its original location, and there supplies a fairly steady demand, which is generally a composite expression of the need for the product in a restricted territory. This may be comprehended if it is remembered that there are operating to-day, 357 steel foundries. Of these, 182 are said to be making electric steel.

(To be continued.)

According to the Ministry of Labour Report for November, there was an increase of 2.5 per cent. in the number of persons employed in the foundry section of the iron and steel industry as compared with October.

Common Troubles of the Ironfounder.*

By F. Allan.

The troubles of the moulder are legion, but it is the common troubles experienced by the green-sand moulder to which extended reference will be made. Foundrymen are familiar with the scrap pile in the foundry yard, where one can see an informal inquest being held around it at more or less regular intervals, and at which the verdict of no two men may be the same, or where all may be agreed as to the cause of some particular waster.

The unanimous verdict is invariably that it must be solved in order to save further loss.

A casting may be spoiled in numerous ways, and the causes of faults may be many and varied. They may originate in the drawing office, the patternshop, with the foreman moulder, the moulder, or it may alternately be the sand, and coal-dust, the iron, or, possibly, a combination of circumstances that tend to produce the waster.

A Few Common Troubles.

A casting may be spoiled in the running, by being run too quickly, because the downcomer and gates have been too large for the size of the casting, thus carrying away some delicate projecting part of the mould, such as a fine beading, or some sharp projecting corner of sand, thus producing a dirty misshapen casting.

Or it may be by running too slowly, and thus producing cold-shut in thin sections of the casting, or, in the case of large flat-top areas of casting, markings similar to the crazy-work patterns one sees on the old-fashioned cushion covers found in old maids' sitting rooms, light and dark patches, with distinct irregular lines in the face of the iron, which denote that there are places, for a distance at least, where the iron has not properly and thoroughly amalgamated.

Sometimes there is a waster through running a job in the wrong place; of course the choice of location of the runner depends to a great extent on the formation of the casting required. For example, spur wheels and pinions are run from the centre, some other castings are run from the sides, some from the bottom and in various suitable places that are clear of sand projections, where there are no facing edges in direct line with the flow of metal over the face of the mould, and no cores in the way, so that the iron will have a free course, with as little as possible to impede its progress into the furthermost corners of the mould.

Runners.

The method of running and gating a casting is a very important factor in the operation of the making of the mould: so much depends on this apparently simple operation, but there is not very much in a moulder's work that is unimportant.

Right from the beginning of his task, to the finish of it, from watering his heap, to casting his job, the moulder must be careful of little things, as well as big ones.

Seemingly trivial things have to be carefully attended to, for a trifling neglect at any period of the operation may ruin all the good work of hours or days.

Some moulders seem to forget that the iron must first pass through the runner and basin before entering the mould. Therefore, it is advisable to spend a few more minutes to make the runners clean, for one cannot obtain clean castings with dirty runners. All runners should be perfectly clean, the basin, the downcomer and the gate.

Castings are often rendered useless through cold shut. These defects are usually the result of insufficient gating, pouring at too low a temperature, improper venting, using sand too damp and chaplets placed in the wrong position. These are troubles that can easily be remedied by using a little thought and care.

Sometimes a cold shut is due to the iron, which when melted, is sluggish and sets quickly: then a little care when selecting the iron, and quality of the coke for the cupola charges, will remedy the trouble. In fact, most of the troubles could be lessened considerably, by exercising care mixed with commensense and experience.

With iron causing this trouble, a small increase in the silicon content, a reduction of sulphur and possibly a very small increase of phosphorus, will greatly improve the fluidity of the iron, but one should not blame the iron without a good and sufficient reason for so doing.

Another common fault in the foundry is the trouble frequently met with from blowholes, honey-combing and cavities. These are caused by dampness, trapped gases in castings containing many intricate cores; often as a result of cores not being properly and sufficiently vented, for if the air is not led away from the cores direct, it must come through the iron, resulting in a blown casting. Wherever there is a core, gas will generate in a greater or less degree, according to the size and shape of the core and its location in the mould.

Then again, it is probably some small casting, urgently wanted, that is found in the shake out, with a hole in the top large enough to condemn a casting infinitely larger. On examination, one is forced to the conclusion that all the trouble can be attributed to the swab brush, or to too hard ramming, or want of venting. Faults of this kind generally occur in the upper surfaces of a casting, which is one of the reasons that whenever possible surfaces to be machined should be cast in the lowest portion of the mould.

Blowholes, sponginess and honey-combing are caused either by dampness, too hard ramming or by air trapped in the iron: through the mould or cores being insufficiently vented, the air and gas generated by the heat are not able to escape properly, consequently one finds either a blowhole, or porosity which will cause the casting to be scrapped, or will certainly weaken it to a certain extent.

Unsoundness.

When soundness is required in castings, as in working parts, or parts that have to carry heavy loads or stresses, dried moulds are used, because in a dry-sand mould less gas is generated than a green-sand mould.

Iron, properly melted and cast not too hot, will be more free from honey-comb than iron inadequately melted. The best remedy for sponginess in a casting that has been cast with the suitable iron, at the correct temperature, is ample venting, and that is a matter of judgment on the part of the moulder, for one part of a mould may need more venting than another, and the harder a mould is rammed the more venting it will need.

A mould made with a facing-sand mixture containing much clayey matter, will require more venting than one made with a good open-sand facing.

Sponginess may occasionally be found to occur throughout a casting, but it is usually found in the uppermost parts. Blowholes are seldom found except on the top of a casting: often they are covered with a thin shell of iron, which a light tap will break through: sometimes they are not even covered, being simply cavities in the surface of the iron.

Frequently blowholes and honey-combing are found together, so that if a fine wire is introduced into a seemingly small aperture that is visible, it will be found that the defect develops into an extensive cavity.

These defects are chiefly found in the upper sections of a casting, and there are several remedies that can be applied to overcome them, supplemented by careful venting, where clean, sound castings are essential.

The most common methods are, the use of risers and flow-off gates, and the addition of feeding heads. Whilst the prime function of a riser is

* Extracted from a Paper read before the Newcastle Branch of the Institute of British Foundrymen, Mr. E. Wood presiding.

to relieve the strain on the top part, due to the iron in the mould expanding the air and gases, it also provides a means of escape for the sullage which would otherwise lodge in the top of the casting.

A flow-off gate naturally involves a riser from which metal is allowed to run away from the head basin, for a short period, after the mould is full, to ensure that the air, gas and sullage have been washed away from the casting.

A feeding head is a fairly sure preventive of sponginess in the body of a cylindrical casting. It not only receives the air and gases and sullage in the iron, but, if of sufficient height, it increases the pressure on the casting itself to a certain extent, thus tending to feed more surely than a rod through a single riser. It must always be borne in mind that head height, and not head mass, is the essential.

Draws.

Draws which are of a different character from blowholes or honey-combing are caused by uneven thicknesses meeting suddenly, as at a right angle bend, or a thick rib coming into a much thinner plate. Draws are more pronounced when the iron is tough and strong than when a weaker grey iron is used. They are not due to air or gas as blowholes are, but to shrinkage or contraction. While the walls of a blowhole are generally smooth, those of a draw when fractured are found to be rough and jagged.

As a blowhole is a development of honey-combing so a draw is a condition of open grain, or of coarse crystallisation. Where a soft iron would develop coarse grain in the interior of a heavy disproportionate mass, a tough mottled iron would if proportioned in the same manner develop a draw, or tear when fractured.

While blowholes occur mainly on the upper parts of a casting because the gases rise to the top, draws are found on any part of a casting where uneven thicknesses meet, or where some bulky part joins a light section.

When a casting is of such a design that draws are likely to occur, and that design cannot be altered or modified, there are several methods that may be used to combat the trouble. One method is to place a feeding head over the heavy part, and feed the casting, keeping the iron in agitation with a feeding rod, and a supplementary supply of hot iron, thus keeping the feeding head fluid until the iron in the mould freezes. It is simply a case of supply and demand; the casting in its semi-liquid state demands more iron to fill up the cavities caused by shrinkage, and the feeding process supplies that demand. Sometimes chills can be used to help the regular shrinkage in a casting.

Scabs.

Scabbed castings make their appearance very frequently. The moulder alone is responsible for this kind of trouble: he has either used his sand too wet, or rammed it too hard, or has not vented it sufficiently, or has poured his job too hot. The iron does not lie comfortably on its bed, but bubbles, and is in a state of agitation, while the mould is filling. It consequently takes away some of the sand from the face of the mould, and the iron occupies the place where the sand should be, thus leaving an unsightly lump on the casting with a corresponding amount of dirt in some other part.

Scabs often occur through the fracture of some weak corner or section of sand against which the iron is allowed to beat while the mould is filling. These places should be well nailed and vented, and, if any doubt exists in the mind, a little drying will stiffen the weak points. Wherever possible the iron should be run into the mould at some point away from the weak places, so that it may rise gently and quietly around them.

Then there is a condition directly opposite to that of scab caused by swelling on the face or sides of a casting. This results from the mould not being rammed firmly enough to withstand the strain of the molten iron. The obvious remedy is to ram the mould firmer.

When cores have been misplaced, such as straight through, round or square holes, they are found to be out of the perpendicular, due to faulty setting in the mould, and sometimes due to inadequate prints on top or bottom of the pattern.

Unnecessary work and trouble can be avoided in the foundry if there is reasonable co-operation between the draughtsman, the patternmaker and the moulder. The greater part of the troubles that harass the foundryman could be minimised if the draughtsman had a general acquaintance with foundry practice. It is only too true that many capable draughtsmen do not know the most elementary facts about foundry work from the moulder's point of view.

This is very often due to the fact that they have lacked the opportunity of gaining first-hand foundry experience, by reason of circumstances over which they have had no control. It is difficult for some of these men to grasp the method of moulding very simple jobs, but if the young draughtsman realised what a great help in his work some real practical knowledge of foundry practice could be he would use every means in his power, and every opportunity that presented itself, to acquire the capacity for knowing where to increase thickness and where to reduce it, and why.

Thickness.

Proportionate metal is what every draughtsman ought to aim at wherever possible, but we all know and realise that at times this is impossible, for often the meeting of many ribs at one point, or the shape of one or more cores butting into another, creates disproportionate lumps of iron in a casting.

It must therefore be left to the moulder to exert his craftsmanship to overcome the difficulty, and if he has studied the peculiarities of iron whilst freezing and the method of using feeders and chills, there should be little difficulty in appreciably minimising the risks arising from such conditions.

Patternmaking sometimes is responsible for a considerable amount of trouble and worry on the part of the moulder that is unnecessary, for all foundrymen have heard it said of a pattern at some time or other, "It's only a oncer," meaning that there is only to be one off, and then encountered troubles which have made it essential to alter the pattern in the foundry, thus adding cost to both departments and frayed tempers all round.

It is very important that the patternmaker should know precisely how the pattern is to be moulded and drawn out of the mould, for in many cases a few extra shillings spent on patternmaking will save pounds in the foundry and machine shop, and also minimise the risks that attend the casting of work that is required to be machined on various parts.

While there is still a minority of patternmakers who turn out their work with little thought of how it will be moulded, there are others who make patterns which are almost, if not quite, ideal, and in this latter event the moulder's task becomes a pleasure.

Then, again, there is the human element, which is, undoubtedly, the greatest trouble, for no two men are alike; and whilst on this topic a quotation culled from an old FOUNDRY TRADE JOURNAL, dated September, 1902, may be of interest. It is as follows:—

"Don't get into dirty habits, for dirty workmen nearly always make dirty castings."

"Don't let dirt and sand accumulate round your feet so that you have to stand upon a hill to work. It's untidy and wasteful."

"Don't get disheartened when you have a waster; there is such a lot to be learned from wasters."

"Don't use too much water, for water put on a green-sand mould is converted into steam when the molten iron comes into contact with that part, and steam, by its expansive force, will blow the molten metal up through the runner and risers."

"Don't forget that all sand generates gas, and this gas must get free exit; if you don't make proper provision for it to escape, it will make a way for itself and spoil the casting."

"Don't ram a pattern up in the sand until you can see a way to draw it out. I have known some moulders who have had to start all over again because they would not trouble to think a job through. I once heard a very good moulder

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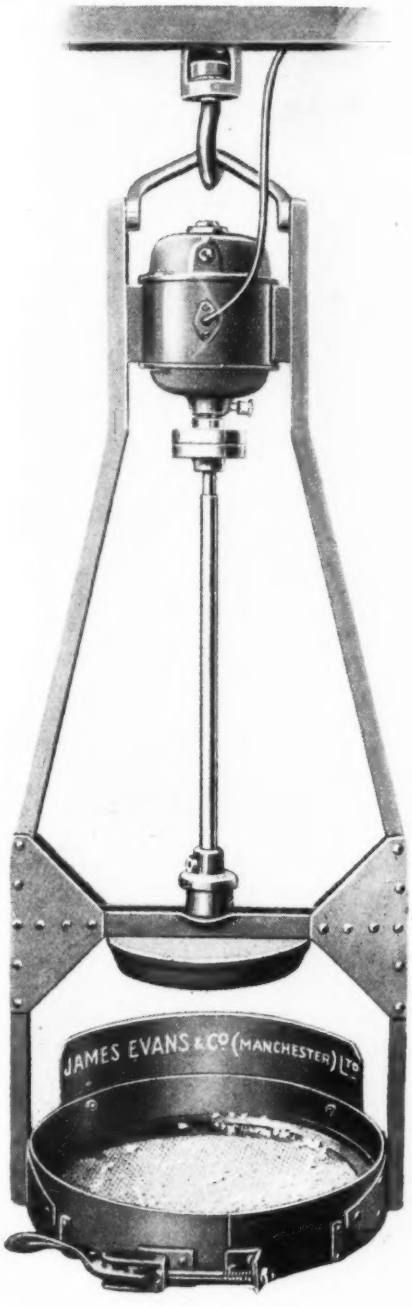

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say, 'Make the job in your mind before you make it in sand, then you will be safe.'"

DISCUSSION.

In opening the discussion, MR. J. W. FRIER said that he had listened with great interest to Mr. Allan's remarks. The question arose, however, what was the proper casting temperature? So far as venting was concerned, he had made dry sand castings without vents for many years. If a job was poured too hot, it was not necessarily the fault of the moulder—he may have been told that the metal was ready, and to get on with the casting. Undoubtedly the running of a mould was frequently done in a very off-hand way. Sometimes moulds were run from the bottom, and sometimes from the top, and frequently with very little attempt at standardising the size of runners and gates.

MR. WEIR said that in his opinion the patternmaker could do much to obviate trouble in the foundry, because not only the design of the patterns, but also the construction of them, was very important. Nowadays, in connection with Diesel work, castings were subjected to a very rigorous inspection, and he had seen some castings recently that had been condemned, and in which it would almost require a microscope to detect the flaw. In this particular casting the Inspector pointed out a hole in which it was most difficult to insert a needle.

A Poser.

THE PRESIDENT (Mr. Wood) stated that there was one trouble in the iron foundry which Mr. Allan had not mentioned—why was it that when a casting was needed urgently it was frequently a failure, and yet, if that same casting were not wanted at once, it would be cast almost within a shorter time and yet be a good one?

MR. S. CARR said that, speaking as a patternmaker, he would suggest that lack of standardisation in foundry practice was the cause of a great deal of the usual troubles met with. Mr. Allan had referred to some moulders casting the same type of casting from the top and others from the bottom, and he (Mr. Carr) thought there must surely be only one correct way. Similarly, some moulders vent their dry sand moulds, whilst others do not. He asked whether it is better to vent an oil sand core from the bottom or from the top, assuming, of course, that both ends were equally accessible.

THE PRESIDENT, referring to Mr. Carr's remarks, said that there did not appear to be any standard way of running certain castings. For example, he believed that it was common experience in most foundries to run a particular type of casting one way for, perhaps, two or three years, and then, in consequence of a failure, to run it another way. This second method was then continued until trouble again occurred, when perhaps the original method would be once more resorted to.

MR. JAMES SMITH referred to the experience which was to be gained from failures, and said he could well remember one or two particular cases in his earlier days, the experience of which had been most valuable to him. He had found that in the case of a faulty casting it was not much use asking various people their opinion as to why it was bad; it was generally only the man who had actually made the mould who could really say what was the cause of the failure.

MR. F. H. REID, a visitor, said that he had been deeply interested in some of Mr. Allan's remarks, particularly in reference to the drawing office side. He agreed with Mr. Allan as to the many difficulties due to design, and thought that was partly due to the employment of draughtsmen whose training had not included actual foundry work. He considered foundrymen partly to blame in this matter, because he had found that only very few foundry apprentices ever tried to get proper technical education. The result of this was that very few foundry apprentices were sufficiently trained to enter the drawing office.

Author's Reply.

In reply to the discussion, MR. ALLAN said casting experience showed what temperature was most suitable for different types of castings, particularly in repetition work. Mr. Wood had asked why it was that, if a casting was required in a hurry, it was generally a bad one. He (Mr. Allan) supposed it was due to the human element and the moulder's over-anxiety to make a good job. In reference to standardising foundry work, he thought that there were sufficient troubles in the foundry without attempting to do everything to rule. In an oil sand core a vent could be taken either from the top or the bottom of the mould so long as it was clear. Mr. Reid had referred to the lack of knowledge of foundry work among draughtsmen. He quite agreed with Mr. Reid, and he also believed that foundry apprentices showed little desire to gain any technical knowledge. He could remember when evening classes for foundry apprentices had been held in Sunderland, and they had been discontinued because so few attended.

On the motion of Mr. E. Wood, seconded by Mr. Weir, a hearty vote of thanks was accorded Mr. Allan for his Paper.

In a 16th Century Foundry.

BY J. E.

Keeping a technical notebook has more than a utilitarian value. Turning over the pages of a notebook some 15 to 20 years old recently the author came across a description of the method of casting backs for organ pipes of lead and tin in a French foundry at the close of the 16th century or the beginning of the 17th century. The compiler was one Salomon de Caus.

"Before I speak of the measurements of organ-pipe backs I will show how lead and tin should be prepared for the work. The softest and oldest lead should be taken, provided it be of best quality and has no solder. Then a stone table, or else a good smooth wooden table of 12 ft. to 15 ft. in length and 1½ ft. to 2 ft. in width, is used with one end higher than the other, so as to have an inclined plane, down which the metal can flow. According to the thickness of the lead, the table must be tilted in proportion as the lead is to be thinner or thicker. In order to make the sheet metal as smooth as possible, the table should be covered with two or three layers of fustian or ticking and fastened to it.

"A small box, which is made to slide along the length of the table, encloses the fused lead on three sides, namely, on the rear end and the two adjacent sides, leaving the front open for pouring the metal. Before pouring the lead it must be tested by thrusting a piece of paper into the lead bath and withdrawing it immediately. If the paper catches fire, the lead is too hot, but if the colour of the paper changes to red, the lead is just of the right temperature and will flow easily.

"One man must now hold the ladle and pour the metal, while the other will move the box mentioned before along the inclined surface of the table. If the lead is to be in a thick sheet, he draws the box along slowly; if in a thin sheet, he draws it faster. Care must be taken to draw the box along at a uniform rate as otherwise the lead will vary in thickness at different points. If the tin which is also used for the organ comes from England, it can be used for casting and will give better results, 5 to 6 lbs. of lead being mixed with 100 lbs. of tin."

The description is perhaps all the more interesting because the methods in use to-day are, we believe, very similar, castings being more satisfactory than sheet metal.

A JOINT MEETING of the Sheffield and district foundry metallurgical and engineering societies was held at the University on December 17, under the chairmanship of Mr. G. Edginton, president of the Sheffield and District Branch of the Institute of British Foundrymen. Mr. J. E. Hurst, of Newton, Chambers & Company, Limited, lectured on the influence of sulphur in cast iron. Mr. R. Hyde was presented with a diploma for his paper given before the Sheffield Branch of Foundrymen last session on "The Improvement of Cast Iron."

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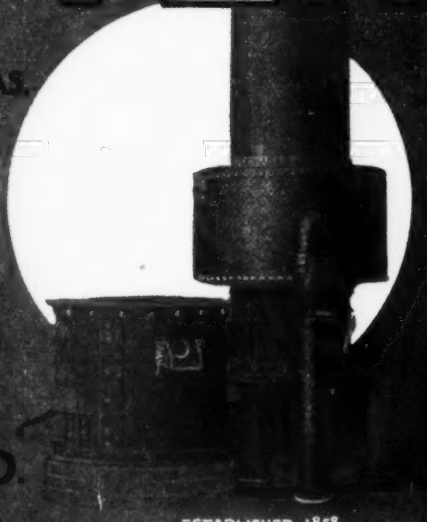

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Trade Talk.

JOHN & EDWIN WRIGHT, LIMITED, have changed their name to Wrights' Ropes, Limited.

C. A. PARSONS & COMPANY, LIMITED, Heaton, Newcastle-on-Tyne, propose erecting a new pattern shop.

THE MOND NICKEL WORKS at Clydach, which were obliged to stop some weeks ago owing to lack of coal supplies, have restarted.

J. T. BANNER, iron, steel and mineral merchant, of Sedgley, Staffs, is retiring from business as a merchant, but will continue as an agent.

KEK, LIMITED, grinding specialists, of Aldwych House, London, W.C.2, report recent orders for 19 Kek grinding and blending mills for Great Britain and abroad.

PALMERS SHIPBUILDING AND IRON COMPANY, LIMITED, Jarrow and Hebburn, have booked an order for another oil tanker for the Gulf Refining Company, of Philadelphia.

GJERS, MILLS & COMPANY, LIMITED, Middlesbrough, announce that they intend to put their Ayresome Ironworks into full operation early in January, subject to their being able to obtain supplies of fuel.

IN CONNECTION with the electrification of the Southern Railway suburban lines, Metropolitan-Vickers Electrical Company, Limited, have secured the contract for the complete electrical equipment for 232 motor-coaches of 550 h.p. each, and 210 trailer-coaches.

THE NEW TITLE of the Blyth Shipbuilding and Dry Docks Company, which was recently acquired by Mr. R. Stanley Dalgliesh, is the Cowpen Shipbuilding and Dry Docks Company, and Sir Arthur Sutherland, Sir Walter Runciman and Mr. Leslie Runciman have been elected directors.

A CONTRACT HAS JUST BEEN PLACED for structural steelwork for an imposing new building in Shanghai for David Sassoon & Company. The total weight of steel involved exceeds 5,000 tons, and the order has been secured by Dorman, Long & Company, Limited, Middlesbrough, in competition with American manufacturers.

THE WELCOME NEWS was received at Cleator Moor that the Whitehaven Hematite Iron & Steel Company, Limited, had decided to blow in one of their furnaces at Cleator Moor, and the preliminary operations have already been started. This will be one of the first furnaces to be restarted in West Cumberland.

THE CONTRACT for the supply of steelwork for the extensions to the Manchester Corporation Electricity Works at Barton has been placed with Edward Wood & Company, Limited, Ocean Ironworks, Manchester. Approximately 1,500 tons of steelwork will be required to complete the additions which are to be made to the turbine and pump house, and switch rooms, etc.

WE LEARN that A. & J. Main & Company, Limited, constructional engineers, of Glasgow and London, have acquired a controlling interest in Main Ropeways, Limited, of 47, Victoria Street, S.W.1. Aerial ropeways have undoubtedly a great future before them, both at home and abroad, and with A. & J. Main & Company's extensive manufacturing facilities, and world-wide connections behind them, Main Ropeways, Limited, should now be in an exceptionally strong position to meet the rapidly growing demands for the work in which they specialise. Main Ropeways, Limited, have now removed to Australia House, Strand, W.C.2.

THE SECRETARY of the London Iron and Steel Exchange, 123, Cannon Street, London, E.C.4, has issued the rules of the London Iron and Steel Exchange Court of Arbitration. This Court has been set up by the committee in the belief that it will be of considerable assistance to members of the iron and steel trade by providing them with an Arbitration Tribunal, which will be presided over by gentlemen having a thorough knowledge of all branches of the trade. The committee has also adopted a scheme of simple arbitration by which minor disputes can be dealt with inexpensively and with a minimum expenditure of time and trouble to the parties to the dispute.

JOHNSON & PHILLIPS, LIMITED, of Charlton, Kent, have received an important contract from the Southern Railway in connection with the electrification of suburban lines on the third-rail system, to Caterham, Tattenham Corner and Epsom Downs, via Streatham and Mitcham, Norwood and West Croydon. The work will involve the manufacture and laying of 78 miles of high-tension cable. One of the provisions of the contract is that the section of line to Tattenham Corner and Epsom Downs shall be ready by Derby Day, 1928. Owing to the company's increased facilities, the whole of the cable required will be manufactured at their works at Charlton. Johnson & Phillips, Limited, also announce that November constituted a record as regards the value of orders booked, which include many large contracts in connection with electricity supply schemes.

A LECTURE ON MOULDING SANDS was given at the December meeting by Mr. J. E. Fletcher, consultant to the British Cast Iron Research Association, to the members of the Middlesbrough Branch of the Institute of Britsh Foundrymen.

THE WASTE INVOLVED by the ordinary oil barrel is one of the chief problems in the handling of lubricating and other oils on a large scale. Few storage tanks are so complete and efficient as the new equipment which has just been placed on the market by the Dowson & Mason Gas Plant Company, Limited, of Levenshulme, Manchester. It comprises a steel tank with a semi-rotary wing pump having a non-drip nozzle and a pan with filter to return the surplus. Recording meters can be fitted. But the chief merit of these sets is the arrangement for hoisting the barrel over the tank orifice, so that when the bung is withdrawn the barrel may be left to drain itself to the last drop. This overcomes what is commonly the chief source of wastage in handling barrels.

Gazette.

MR. M. MIRGAIN, 30, Bootle Street, Manchester, metal merchant, has been adjudged bankrupt.

MR. J. SWINSCOE, carrying on business at 1, Queens Road, Coventry, as a steel merchant, is paying a first and final dividend of 1-15/16d. in the £.

A RECEIVING ORDER has been made in connection with the affairs of the St. Mark's Metal Company, 388, Park Road, Hockley, Birmingham, metal casters.

THE NICKEL CORPORATION, LIMITED, are being wound up voluntarily, with Mr. E. Haydock, 2, Metal Exchange Buildings, Leadenhall Avenue, London, E.C., as liquidator.

MESSRS. A. E. BARNSHAW AND E. H. HOLT, steel founders, Glen Side Works, Hebburn, trading under the style of the Crucible Steel Castings Company, have dissolved partnership.

MESSRS. E. SPENCER, J. WARD, J. B. WARD and L. R. WARD, engineers, 49, Old Mill Lane, Formby, trading under the style of the Formby Engineering Company, have dissolved partnership.

THE APPLICATION FOR DISCHARGE of Mr. R. Johnson, carrying on business at 12, Queen Street, Manchester, metal and wire merchant, will be heard on January 17, 1927, at the Court House, Quay Street, Manchester.

MESSRS. W. SHORE, G. W. HALE AND W. A. LATHBURY, die and tool forgers and stampers and piercers, 42, Howard Street, Birmingham, trading as Messrs. Shore, Lathbury & Company, have dissolved partnership.

THE DISCHARGE FROM BANKRUPTCY of Mr. W. H. Cook, Beehive Wharf, Brentford, Middlesex, managing director of Fastnut, Limited, has been granted subject to the debtor consenting to judgment for £25 and 30s. costs.

MESSRS. J. W. ATTACK AND E. WILLIAMS, general engineers and millwrights, Junction Engineering Works, Victoria Road, Morley, trading under the style of Attack & Williams, have dissolved partnership. Mr. J. W. Attack will continue the business under the same style.

Personal.

MR. C. T. D. BURCHELL has been elected a director of Bullers, Limited.

MR. A. HAYTON COWAP has been elected a director of the Power-Gas Corporation, Limited.

MR. DUNCAN MARSH, who has since 1919 been secretary of Brunner, Mond & Company, Limited, has been elected to a seat on the board of that company.

THE DIRECTORS of Nobel Industries, Limited, have released Mr. W. H. Coates from his engagement as secretary to the company, following his appointment as treasurer of Imperial Chemical Industries, Limited. Mr. Edgar Nelson Wise (formerly assistant secretary) has been appointed secretary in his place.

SIR ARCH. M'INNES SHAW has resigned his position as chairman of Halley's Industrial Motors, Limited. Mr. George Wingate has been elected a director to fill the vacancy so caused, and has also been elected chairman. Proposals are being considered by the board with a view to the complete reorganisation of the company.

Wills.

WALLACE, W., of Frederick Street, Oldham, engineer	£10,828
HARRISON, T., of Sunderland, steel and tool merchant	£9,103
DAVIES, W. H., of Lynwood, Bury Old Road, Cheetham Hill, Manchester, bolt and nut Manufacturer	£5,499
LANE, F., of Clifton Gardens, Folkestone, a director of the North British Diesel Engine Works, Limited	£571,510

ON ADMIRALTY, WAR OFFICE AND H.M. INDIA OFFICE LISTS.

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MANUFACTURERS OF ALL KINDS OF REFRACTORY
AND FURNACE BUILDING AND REPAIRING MATERIALS

The GENERAL REFRACTORIES Co. Ltd.

SHEFFIELD
AND ITS STAFF
WISH YOU
A VERY HAPPY AND PROSPEROUS
NEW YEAR

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Secretary:
WILLIAM A. CUTTS.

Asst. General Manager:
THOMAS SINGLETON.

Purchases Director:
ARTHUR WHITELEY.

Sales Director:
GEORGE SENIOR.

Technologist:
COLIN PRESSWOOD.

Cashier:
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JAMES SHAW,
Essendyne House,
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Nr. Halifax.

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J. WALLIS,
The Beeches, Fritchley,
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PARSONS & COLLS, LTD.,
30-32 Side,
Newcastle-on-Tyne.

Continuous expansion of business necessitating increased accommodation for our staff we have secured the commodious offices recently vacated by Messrs. The Brightside Foundry & Engineering Co., Ltd., who have removed to more convenient premises.

OUR NEW ADDRESS is SIMPLE and EASY to REMEMBER—JUST

WICKER ARCHES, SHEFFIELD

(Same Telephone Number as before.)

LONDON OFFICE:
23, Budge Row, E.C.4.
(Mr. A. C. TURNER)
CITY 4277.

Branch, Allied or Associated Works, Mines, Quarries or Agents at—

AMBERGATE.
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SHEFFIELD.
SKEGBY.
SOUTH CAVE.
TOW LAW.
WARSOP.
WOLSINGHAM.
WORKSOP.

No need to try and remember our name in case it is unfamiliar to you. This is our British Monomark. Envelopes addressed simply thus will be delivered to us by arrangement with the G.P.O.

BCM/GRC
LONDON.

IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—Business for the time being is practically non-existent in the Cleveland iron market, which, for obvious reasons, will remain closed during the current holiday season. As already announced, a fair number of furnace plants in the North-Eastern area is already in commission, and many others are in preparation for a restart in the near future, but it will, of course, be some considerable time to come before normal pig-iron production can be assured. Hence for a few weeks the position will be somewhat difficult and business rather restricted. For January delivery 87s. 6d. per ton is quoted for No. 3 G.M.B., and for other qualities the following figures are named:—No. 1, 90s.; No. 4 foundry, 86s. 6d.; and No. 4 forge, 86s. per ton. Business over three months can be done at 85s. per ton for No. 3, and other qualities in proportion.

In the hematite section there is a general impatience to see the various works producing again, but the restart cannot be hurried for several reasons. After such a long time idle the furnaces require a certain amount of preparation, and, further, it was not advisable to rush in and buy fuel too early after the restart. As it is, neither coal nor coke is down to the lowest price yet.

LANCASHIRE.—In the local markets recently there have been offers of Scotch and Middlesbrough pig-iron for prompt delivery at slightly easier rates. Scotch ranging from 127s. 6d. to 130s. and Middlesbrough at round 125s., delivered Manchester or equal distance, but, as far as one can see, there has been little taken up. Derbyshire brands have been offering at 85s. at the furnaces, or about 92s. 6d. delivered Manchester, for January delivery, and 7s. 6d. per ton less than this for February, while Scotch iron is quoted at from 110s. to 117s. 6d.

THE MIDLANDS.—At Birmingham there is practically no change in the prices of pig-iron from those previously quoted. At the present moment Derbyshire No. 3 foundry iron is being quoted from 85s. to 92s. 6d. at the furnaces; the latter price is being obtained for anything that can be dispatched at once. Northamptonshire iron for delivery as soon as circumstances permit is quoted at 82s. 6d. per ton and up at the furnaces.

SCOTLAND.—There are now several pig-iron furnaces in blast in Scotland, but so far none of them has produced pig-iron of a suitable standard for ordinary purposes. However, no doubt this will be put right within the next day or two, and as the production increases it is expected to see prices ease down, although at the moment they are firm at 91s. 6d. to 95s. per ton f.o.t. furnaces for No. 3 foundry.

Finished Iron.

With regard to bar iron, it is anticipated that a number of local forges will be able to operate soon after the holidays. Prices of crown iron vary from £12 5s., the cheapest, to £12 15s. per ton; the lower figures do not come from the Staffordshire district, but from the North and Lancashire. There is not a great deal of business about, and much competition for what there is available. Continental iron still remains rather weak. No. 3 quality for nut and bolt work is being offered at a shade under £6 15s. per ton, for delivery South Staffordshire at the end of January or February. The local makers are unable to come anywhere near this figure, so can hope for little support when they do start up. Marked bars are quoted at £14 10s. per ton f.o.t. makers' works, and it is understood that the makers will have a fair amount of business to cope with for this class of iron when they can resume.

Steel.

There are still no supplies of English soft billets, and not very large ones of higher-quality carbon contents, and no definite information as to when there will be. In the meantime, Continental producers are slowly realising the changed situation, and have brought their price down to £6 2s. 6d. Even at this reduction, however, users are not being induced to contract freely. They are postponing large purchases in the hope of further reductions in the near future. The position of the tinplate market has not materially changed since last week. Business is still on a small scale, and buyers are becoming anxious to obtain delivery of back contracts.

Scrap.

On the termination of the holidays, now in full swing, it is confidently anticipated that the markets for scrap metals will resume more active conditions, the existing shortage of pig-iron being expected to give an immediate stimulus to demand for cast-iron material for cupola purposes, and prices everywhere at the moment evidence a stiffening tendency.

Metals.

Copper.—Indicating the steady position of the markets for base metals during the past twelve months, it may be noted that the closing prices of standard copper last week were quoted at £56 12s. 6d. to £56 15s. cash, as compared with £59 12s. 6d. at the corresponding date last year. The prospects for 1927 are considered good, as copper is being more largely used in the smaller class of residence, and in addition to the increasing quantities consumed by the electrical industry, the metal is also being more freely utilised by the motor-car and motor-cycle trades.

Official closing prices of standard copper have been as follow :—

Cash : Thursday, £56 15s. to £56 17s. 6d.; Friday, £56 15s. to £56 17s. 6d.; Tuesday, £56 7s. 6d. to £56 10s.; Wednesday, £56 10s. to £56 12s. 6d.

Three Months : Thursday, £57 10s. to £57 12s. 6d.; Friday, £57 10s. to £57 12s. 6d.; Tuesday, £57 5s. to £57 6s. 3d.; Wednesday, £57 7s. 6d. to £57 10s.

Tin.—In the more speculative element of standard tin some irregularity has developed. There has been a fairly substantial increase in home stocks, but, contrary to expectations, this has had but little effect on the market. Contrasted with fears entertained a month ago, the American outlet for tin is more likely to expand than contract in the coming year, and there should be at least a recovery in the home outlet.

Official closing prices of standard tin have been as under :—

Cash : Thursday, £302 15s. to £303; Friday, £301 to £301 5s.; Tuesday, £297 15s. to £298; Wednesday, £297 15s. to £298.

Three Months : Thursday, £296 10s. to £296 12s. 6d.; Friday, £295 10s. to £295 15s.; Tuesday, £294 to £294 5s.; Wednesday, £294 7s. 6d. to £294 12s. 6d.

Spelter.—Ordinary brands have been harder, mainly due to very good American statistics indicating a heavier output for November, but deliveries were high, so that the stocks were reduced by 1,428 tons. Consumers have bought sparingly, but there is room for a better demand in the near future. The delay in placing new orders is attributed to the fact that coal is still too dear to permit of increased working by smelters.

The following are the week's prices :—

Ordinary : Thursday, £33; Friday, £32 17s. 6d.; Tuesday, £32 13s. 9d.; Wednesday, £32 15s.

Lead.—Soft foreign pig has attracted good support for March delivery, and in spite of the continuation of ample arrivals and renewed weakness in America the market has improved on balance. The comparatively low price has brought both consumers and speculators into the open.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £29 2s. 6d.; Friday, £29; Tuesday, £28 17s. 6d.; Wednesday, £28 17s. 6d.

Company Reports.

Howard and Bullough, Limited.—Quarterly dividend, 6d. per share, less tax.

Crompton & Company, Limited.—Interim dividend, 7 per cent. per annum on preference shares.

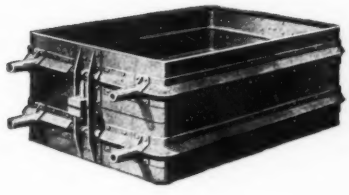
Power-Gas Corporation, Limited.—Profit, £6,232; reserve, £1,222; dividend, 4 per cent. (less tax); carry forward, £12,624.

Redpath, Brown & Company, Limited.—Profit, £84,380; brought in, £9,772; total, £94,152; depreciation reserve, £15,000; dividend, 8 per cent. on ordinary, and bonus 6 per cent., both less tax.

Walter Somers, Limited.—Loss, after payment of debenture interest (£11,107), and charging depreciation (£20,849), £24,475; debit brought in, £152,703; preference dividend paid; total debit balance, £177,400.

Bullers, Limited.—Transferred from reserve, £5,000; profit for year, £3,557; amount brought forward, £5,665; total, £14,222; preference dividend for year, £7,500; transfer to sinking fund for redemption of debentures, £5,807; carried forward, £915.

Sterling



In every class of Foundry and in every Moulding Box service Sterling Boxes soon show their marked superiority, not only in the better quality of work produced but also in increased output per man per hour.

Cast-iron Boxes are excessively heavy, and liable to break at any moment. Boxes made from sheet metal are too flimsy to stand up to the heavy duties of general foundry service.

There is only one remedy . . . the Sterling Rolled Steel Box, with the solid centre reinforcing rib and two stiff sand-retaining ledges. They are light, strong, rigid, accurately made on up-to-date machinery. Cannot crack or break. Cannot distort or get out of truth.

Send your next Moulding Box enquiry to the leading Moulding Box Manufacturers.

WHEREVER CASTINGS ARE MADE

STERLING BOXES

WILL HELP TO MAKE THEM

BETTER & CHEAPER

STERLING FOUNDRY SPECIALTIES LTD.
BEDFORD

London Office: 13, VICTORIA STREET, S.W.1.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	56	10	0
Three months	57	7	6
Electrolytic	63	15	0
Tough	61	15	0
Best selected	62	10	0
Sheets	92	0	0
India	73	10	0
Wire bars	64	15	0
Do. January	64	7	6
Do. February	64	7	6
Ingot bars	64	7	6
H.C. wire rods	68	15	0
Off. av. cash, Nov.57	7	1	25/32
Do., 3 mths. Nov.58	3	11	7/32
Do., Sttlmnt Nov.57	6	11	27/32
Do., Electro, Nov.65	16	0	7/32
Do., B.S., Nov. 64	7	6	
Aver. spot price copper, Nov.	57	7	1¼
Do., wire bars, Nov.66	1	0	3/4

Solid drawn tubes 13d.
Brazed tubes 13d.
Wire 9½d.

BRASS.

Solid drawn tubes 12d.
Brazed tubes 13½d.
Rods, drawn 11½d.
Rods, extd. or rlld. 7½d.
Sheets to 10 w.g 10½d.
Wire 10½d.
Rolled metal 9½d.
Yellow metal rods 7½d.
Do. 4 × 4 Squares 8d.
Do. 4 × 3 Sheets 8½d.

TIN.

Standard cash	297	15	0
Three months	294	7	6
English	296	5	0
Bars	297	15	0
Straits	304	15	0
Australian	301	15	0
Eastern	305	0	0
Banca	299	0	0
Off. avr. cash, Nov. 309	9	1	17/32
Do., 3 mths., Nov. 298	14	9	25/32
Do., Sttlmt. Nov. 309	8	2	7/32
Aver. spot., Nov. 309	9	1	3/4

SPELTER.

Ordinary	32	15	0
Remelted	32	10	0
Hard	27	0	0
Electro 99.9	35	10	0
English	33	7	6
India	29	15	0
Zinc dust	42	0	0
Zinc ashes	14	10	0
Off. aver., Nov.	33	9	8 13/32
Aver., spot, Nov.	33	9	10

LEAD.

Soft foreign ppt.	28	17	6
English	30	10	0
Off. average, Nov. 29	8	3	23/32
Average spot, Nov. 29	5	4	3/4

ZINC SHEETS, &c.

Zinc sheets, English	42	10	0
Do. V.M. ex whf.	39	5	0
Rods	45	0	0
Boiler plates	38	10	0
Battery plates	38	0	0

ANTIMONY.

Special brands, Eng.	74	10	0
Chinese	54	0	0
Crude	35	0	0

QUICKSILVER.

Quicksilver 17 12 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon —			
25%	9	5	0
45/50%	11	17	6
75%	18	10	0

Ferro-vanadium—
35/40% 14/6 lb. va.
Ferro-molybdenum—
70/75% c. free 5/1 lb.
Ferro-titanium—
23/25 % carbonless 11½d.
Ferro-phosphorus, 20/25%, £17 0 0
Ferro-tungsten—
80/85%, c.fr. 1 6 lb.
Tungsten metal powder—
98/99% 1/10 lb.
Ferro-chrome—

2/4% car.	£32	0	0
4/6% car.	£23	5	0
6/8% car.	£21	15	0
8/10% car.	£20	12	6

Ferro-chrome—

Max. 2% car.	£36	0	0
Max. 1% car.	£42	0	0
Max. 0.70% car.	£54	0	0

70%, carbonless 1/5 lb.
Nickel—99%, cubes or pellets £170
Cobalt metal—98/99% 8/3 lb.
Aluminium 98/99% £104
Metallic Chromium—
96/98% 3/3 lb.
Ferro-manganese (net)—

76/80%, loose	£16	0	0
76/80%, packed	£17	0	0
76/80%, export	£16	0	0

Metallic manganese—
94/96%, carbonless 2/- lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.
Extras—
Rounds and squares 3 in. and over 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Do. under ¼ in. to ⅛ in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in. 3d. lb.
Do. under ½ in. × ¼ in. 1/- lb
Bevels of approved sizes and sections 6d. lb.
Bars cut to length 10% extra
Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	3	5	0	to 3	10	0
Bundled steel & shrngs.		2	13	0		
Mixed iron & steel	2	15	0	to 3	0	0
Heavy cast iron	3	5	0	to 3	10	0
Good machinery for foundries	3	10	0	to 3	15	0
Cleveland—						
Heavy steel	3	12	6			
Steel turnings	2	7	6			
Cast iron borings	2	5	0			
Heavy forge	4	5	0			
Bushelled scrap	3	10	0			
Cast-iron scrap	3	17	6	to 4	0	0
Lancashire—						
Cast-iron scrap	3	10	0			
Hvy. wrought	3	2	6			
Steel turnings	1	17	6			
London — Merchants' buying prices delivered yard.						
Copper (clean)	49	0	0			
Brass (clean)	39	0	0			
Lead (less usual draft)	26	10	0			
Tea lead	22	10	0			
Zinc	22	0	0			
New aluminium cuttings	82	0	0			
Braziery copper	45	0	0			
Gunmetal	48	0	0			
Hollow pewter	190	0	0			
Shaped black pewter	140	0	0			

PIG-IRON.

(*f.o.t. unless otherwise stated*).

N.E. Coast -	
Foundry No. 1	90/-
Foundry No. 3	87 6
Foundry No. 4	86 6
Forge No. 4	86/-
Hematite No. 1	—
Hematite M/Nos.	90/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	—
„ d/d Birm.	—
Midlands—	
Staffs common*	—
„ No. 4 forge	—
„ No. 3 foundry	92/6
Shrops. basic	—
„ Cold blast, ord.*	—
„ „ roll iron*	—
* d/d Birmingham.	
Northants forge	—
„ fdry No. 3	92/6 and upwards
Derbyshire forge	—
„ fdry. No. 3	85/- and upwards
„ basic	—
Scotland—	
Foundry No. 1	—
„ No. 3	91/6 to 95/-
Hem. M/Nos.	—
Sheffield (d/d district)—	
Derby forge	—
„ fdry. No. 3	90/-
Lincs. forge	—
„ fdry. No. 3	—
E.C. hematite	—
W.C. hematite	—
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3	92/6
Northants foundry No. 3	—
Dalzell, No. 3	112/6
Summerlee, No. 3	112/6
Glengarnock, No. 3	—
Gartsherrie, No. 3	112/6
Monkland No 3	112/6
Coltness, No. 3	112/6
Shotts, No. 3	112/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.	12	10	0	to 12	15	0
Angles					—	
Tees to 3 united ins.					—	
Nut and bolt iron					—	
Hoops				14	10	0
Marked bars (Staffs.) f.o.t.				14	10	0
Gas strip				12	10	0
Bolts and nuts ½ in. × 4 in.				15	5	0
Steel—						
Ship plates				8	17	6
Boiler plts.				11	5	0
Chequer plts.				10	5	0
Angles				8	2	6
Tees				9	2	6
Joists				8	2	6
Rounds and Squares 3 in. to 5½ ins.				8	5	0
Rounds under 3 in. to ⅜ in. (Untested)				8	15	0
				and upwards		
Flats, over 5 in. wide and up				9	10	0
Flats, 5in. to 1½in.				8	10	0
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs.)				10	10	0
Black sheets, 24g.				12	12	6
Galv. cor. shts, 24g.				16	15	0
Galv. fencing wire 8g. plain				12	10	0
Billets, soft				7	0	0
				and upwards		
Billets, hard				—		
Sheet bars	7	0	0	to 7	10	0
Tin bars d/d	7	0	0	to 7	10	0

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to 10 w.g.	1	3½
Wire	1	4
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

Per lb.
Ingots for raising 9d. to 1/3
Rolled—
To 9 in. wide 1/3 to 1/9
To 12 in. wide 1/3½ to 1/9½
To 15 in. wide 1/3½ to 1/9½
To 18 in. wide 1/4 to 1/10
To 21 in. wide 1/4½ to 1/10½
To 25 in. wide 1/5 to 1/11
Ingots for spoons and forks 9d. to 1/5½
Ingots rolled to spoon size 1/- to 1/8½
Wire round—
3/0 to 10 G. 1/6½ to 2/1½
with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	22.76
No. 2 foundry, Valley	19.00
No. 2 foundry, Birm.	20.00
Basic	20.26
Bessemer	21.76
Malleable	20.76
Grey forge	20.26
Ferro-mang. 80% d/d	100.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.22
Steel bars	2.00
Tank plates	1.90
Beams, etc.	2.00
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.50
Sheets, black, No. 24	3.00
Sheets, galv., No. 24	3.85
Sheets, blue an'l'd, 9 & 10	2.30
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry —
„ furnace —
Durham & North.
„ foundry —
„ furnace 25/-
Other Districts, foundry —
„ „ furnace (basis) —

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes, 20×14, box		21/9
„	28×20, „	43/6
„	20×10, „	—
„	18¾×14, „	—
C.W.	20×14, „	20/-
„	28×20, „	—
„	20×10, „	—
„	18¾×14, „	—

Terneplates 28×20, — per box basis f.o.b.

SWEDISH IRON.

Bars, hammered £18/10 to £19/0
Rolled Ord. £15/10/0 to £16
Nail rods £16 5 0 to £16 15 0
Keg. steel nom. £33 to £35
Faggot steel nom. £22 to £25
Blooms, according to quality £9 to £12
Pig-iron £6 0 0 to £6 10 0 all f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes	Fittings
Gas	67½%	45%
Water	62½%	40%
Steam	57½%	35%

W.I. 10% extra.

Electrolytic Copper.

	£	s.	d.	
Dec. 23	64	5	0	No change
,, 24	64	5	0	,, ,,
,, 28	64	5	0	,, ,,
,, 29	63	15	0	dec. 10/-

Tin (English ingots).

	£	s.	d.	
Dec. 23	300	15	0	dec. 20/-
,, 24	299	0	0	,, 35/-
,, 28	295	15	0	,, 65/-
,, 29	296	5	0	inc. 10/-

Spelter (ordinary).

	£	s.	d.	
Dec. 23	33	0	0	dec. 2/6
,, 24	32	17	6	,, 2/6
,, 28	32	13	9	,, 3/9
,, 29	32	15	0	inc. 1/3

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
Dec. 23	56	15	0	inc. 2/6
,, 24	56	15	0	No change
,, 28	56	7	6	dec. 7/6
,, 29	56	10	0	inc. 2/6

Standard Tin (Cash).

	£	s.	d.	
Dec. 23	302	15	0	dec. 20/-
,, 24	301	0	0	,, 35/-
,, 28	297	15	0	,, 65/-
,, 29	297	15	0	No change

Zinc Sheets (English).

	£	s.	d.	
Dec. 23	42	10	0	No change
,, 24	42	10	0	,, ,,
,, 28	42	10	0	,, ,,
,, 29	42	10	0	,, ,,

Lead (English).

	£	s.	d.	
Dec. 23	30	15	0	No change
,, 24	30	15	0	,, ,,
,, 28	30	10	0	dec. 5/-
,, 29	30	10	0	No change

AVERAGE MONTHLY PRICES OF RUBIO ORE (MIDDLESBROUGH).

	Jan.			Feb.			March			April			May			June			July			Aug.			Sept.			Oct.			Nov.			Dec.			Yearly Average		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1890	0	15	4	0	15	4	0	15	4	0	15	4	0	15	4	0	15	4	0	15	4	0	14	3	0	11	3	0	15	7½	0	15	7½	0	15	7½	0	15	2¾
1891	0	15	7½	0	14	2½	0	14	2½	0	14	2½	0	13	6½	0	13	6	0	13	3¾	0	13	0	0	12	11	0	13	0	0	13	7	0	13	1	0	14	9½
1892	0	13	1·	0	12	9	0	12	9	0	12	9	0	12	9	0	11	10½	0	12	1	0	12	1	0	12	2	0	12	0	0	12	0	0	11	11	0	12	4½
1893	0	11	11	0	11	5½	0	11	10	0	11	10	0	12	1½	0	12	3	0	12	1¼	0	12	3	0	12	1	0	12	4	0	12	4½	0	12	6	0	12	0¾
1894	0	12	6	0	12	6	0	12	7½	0	12	1¾	0	12	4	0	12	1	0	12	0	0	12	0¾	0	11	10½	0	12	2	0	12	0	0	12	0	0	12	1¼
1895	0	12	0	0	12	0	0	11	10	0	12	0	0	12	0	0	12	3	0	12	3	0	12	4	0	12	4	0	12	6	0	12	7	0	12	6	0	12	2¾
1896	0	12	6	0	12	6	0	12	9	0	12	9	0	12	9	0	12	7	0	12	9	0	12	9	0	12	9	0	13	6	0	15	0	0	14	9	0	13	1
1897	0	15	3	0	15	6	0	15	3	0	15	0	0	14	0	0	14	3	0	14	3	0	14	0	0	14	0	0	15	0	0	14	3	0	15	3	0	14	8
1898	0	15	0	0	14	4	0	14	9	0	14	6	0	15	0	0	15	0	0	14	0	0	14	0	0	14	0	0	14	9	0	15	0	0	14	9	0	14	7
1899	0	15	0	0	15	3	0	15	6	0	15	6	0	15	9	0	16	0	0	17	6	0	18	0	0	17	9	0	18	0	0	19	0	1	0	0	0	16	11½
1900	1	1	0	1	0	6	1	1	0	1	0	9	1	1	0	1	1	0	1	1	3	1	1	6	1	1	3	1	1	3	1	0	0	0	18	0	1	0	8½
1901	0	17	6	0	16	0	0	15	0	0	14	6	0	15	6	0	15	9	0	14	9	0	15	3	0	15	9	0	15	9	0	15	9	0	15	9	0	15	7½
1902	0	15	6	0	15	0	0	16	0	0	16	0	0	15	6	0	15	3	0	15	6	0	16	0	0	16	0	0	16	0	0	15	9	0	15	6	0	15	8¼
1903	0	15	6	0	16	0	0	16	6	0	16	3	0	16	3	0	16	10	0	15	9	0	15	6	0	15	6	0	14	9	0	14	9	0	15	1	0	15	8
1904	0	14	9	0	15	3	0	15	1	0	15	4	0	15	3	0	15	0	0	14	5	0	14	6	0	14	6	0	14	6	0	14	6	0	14	7	0	14	9¾
1905	0	15	3	0	15	6	0	15	0	0	15	3	0	15	6	0	15	6	0	15	6	0	15	6	0	16	6	0	18	6	0	18	9	0	18	9	0	16	3¾
1906	1	0	0	1	1	6	1	0	0	1	0	0	0	19	6	1	0	0	0	19	6	0	19	4	1	0	6	1	1	6	1	1	9	1	3	6	1	0	7
1907	1	3	6	1	2	6	1	2	6	1	2	0	1	1	6	1	2	3	1	2	3	1	2	0	1	1	0	0	19	0	0	18	9	0	17	6	1	1	2¼
1908	0	16	6	0	15	0	0	15	6	0	15	6	0	15	3	0	15	0	0	15	0	0	14	9	0	15	0	0	16	0	0	16	0	0	16	0	0	15	5½
1909	0	15	9	0	16	3	0	16	0	0	16	0	0	16	3	0	16	6	0	16	0	0	16	0	0	17	0	0	17	0	0	17	6	0	17	6	0	16	6
1910	1	0	4	1	0	9	1	0	9	1	0	9	1	0	9	1	0	9	1	0	9	1	0	3	1	0	3	1	0	6¾	1	1	3	1	1	5	1	0	9¾
1911	1	2	2½	1	2	6	1	2	6	1	1	11½	1	0	11½	0	19	6	0	19	0	0	19	0	0	19	1½	0	19	6	1	0	0¾	1	1	6¼	1	0	7½
1912	1	2	3	1	2	6	1	2	6	1	1	1½	1	1	6	1	1	6	1	1	6	1	2	3	1	2	6	1	3	0	1	3	0	1	2	11	1	2	2¼
1913	1	2	9	1	2	2	1	1	7½	1	1	6	1	0	8½	1	0	0	1	0	0	1	0	0	0	19	10½	0	19	1½	0	19	0	0	19	0	1	0	5½
1914	0	18	7½	0	18	0	0	18	0	0	17	9	0	17	6	0	17	6	0	17	1½	0	19	7½	0	18	11½	0	17	10½	0	18	7½	1	1	0½	0	18	5½
1915	1	7	7½	1	8	6	1	9	3	1	10	2½	1	8	6	1	6	4	1	5	10½	1	6	0	1	6	10½	1	10	8¼	1	13	0	1	17	10	1	9	1½
1916	1	18	6	2	0	1½	2	2	6½	2	0	6½	1	15	0	1	16	3	1	18	0	1	18	0	1	18	0	—			—			—			—		
1917	} Price Fixed.																																						
1918																																							
1919	—			—			-			—			2	5	7½	2	14	4½	2	16	4½	2	14	0	2	13	4½	2	13	0	2	12	7½	2	11	9		—	
1920	2	17	0	3	7	9	2	15	6	3	6	7	3	0	0	2	15	0	2	14	0	2	9	9	2	7	6	2	11	0	2	12	3	2	10	0	2	15	0
1921	2	1	0	2	0	1½	1	18	3	1	17	6	1	17	6	1	17	6	1	17	6	1	5	0	1	8	9½	1	7	9	1	7	0	1	7	0	1	13	8½
1922	1	6	7½	1	5	10½	1	6	11	1	7	0	1	7	0	1	7	0	1	5	3	1	4	9¾	1	4	2½	1	3	3¾	1	2	6	1	2	3	1	5	2½
1923	1	2	9¾	1	4	6¾	1	5	2	1	4	8½	1	4	6	1	4	0	1	3	6	1	3	0	1	3	0	1	3	0	1	3	2½	1	4	9	1	3	10¾
1924	1	4	2½	1	4	0	1	4	0	1	3	7½	1	3	8½	1	3	6	1	2	11	1	2	6	1	2	1½	1	1	7½	1	2	3	1	2	6	1	3	1·
1925	1	2	6	1	2	1½	1	2	0	1	2	0	1	2	0	1	1	6	1	0	6	1	0	0	1	0	0	1	0	0	1	0	3	1	0	10½	1	1	1½
1926	1	1	1½	1	1	6	1	1	6	1	1	3½	1	1	3	1	1	5½	1	1	6	1	1	6*	1	1	0*	1	1	6*	1	1	6*		*		1	1	4½

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The Proprietors of the FOUNDRY TRADE JOURNAL have placed this space at the disposal of the British Legion, Officers' Association, Employment Bureau, 3-4, Clement's Inn, Strand London, W.C.2. (telephone: Holborn 5769), to whom all replies should be addressed, quoting number of advertisement, date on which it appeared, and the name of this paper.

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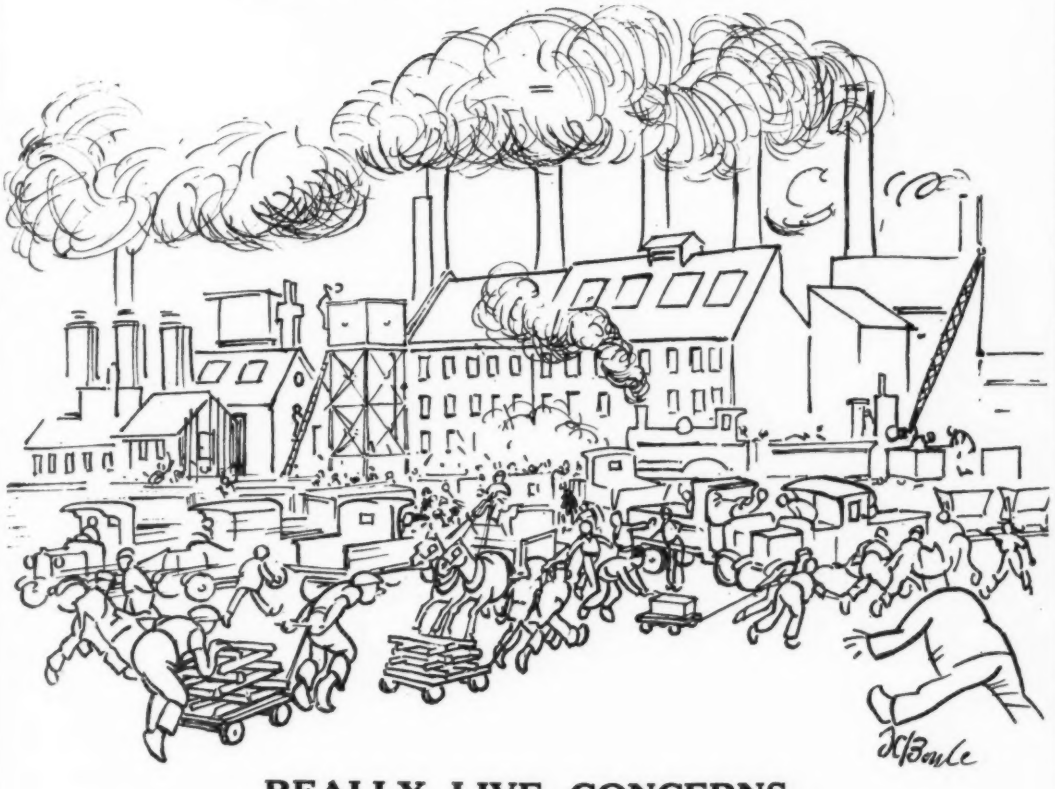

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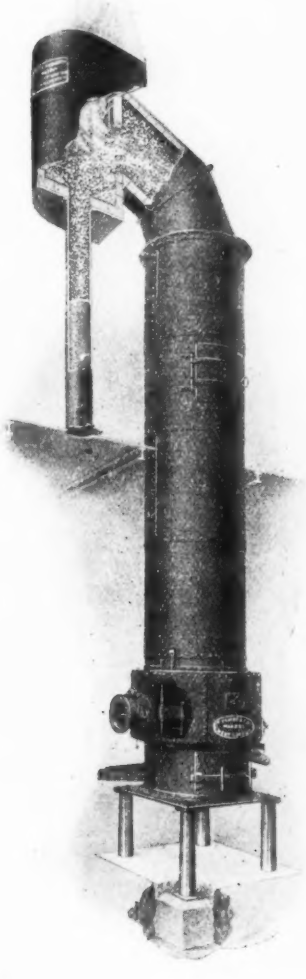

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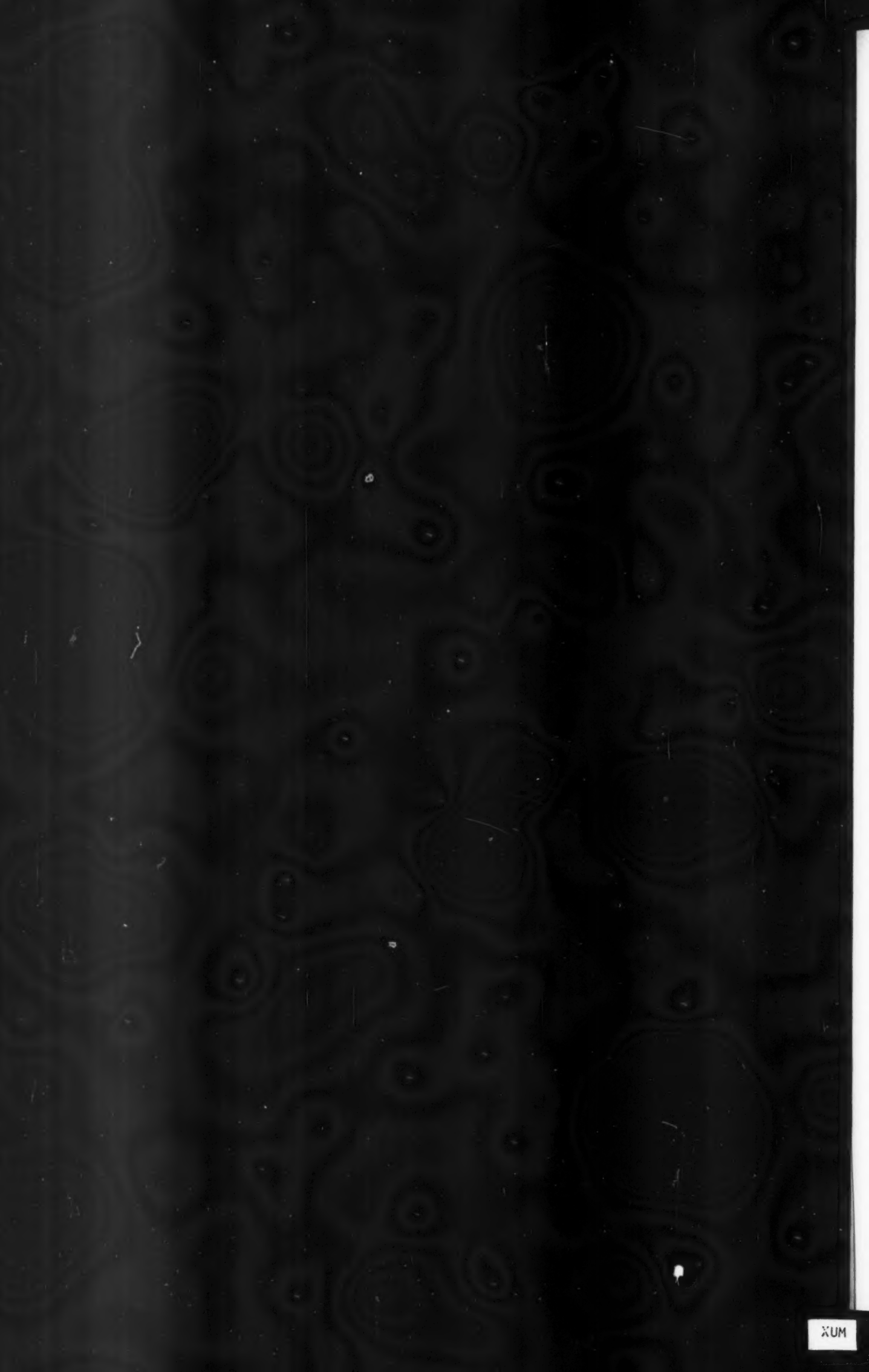

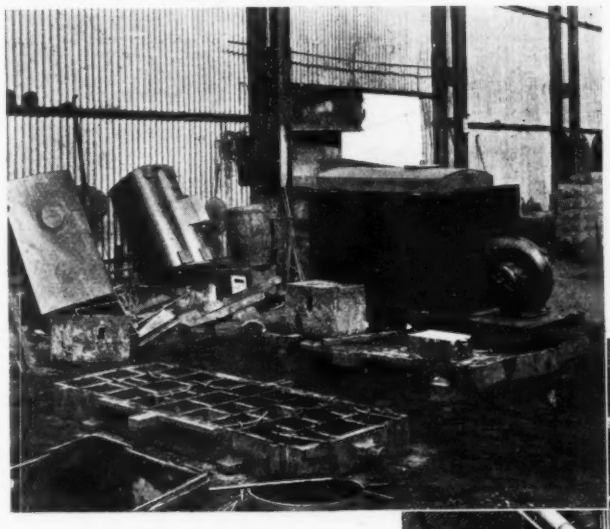

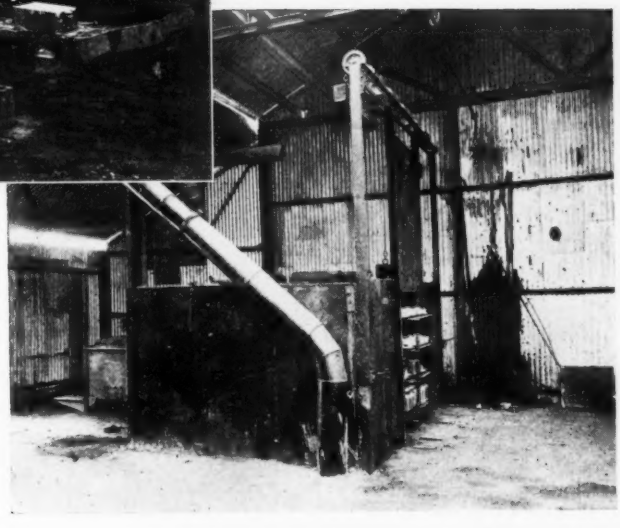

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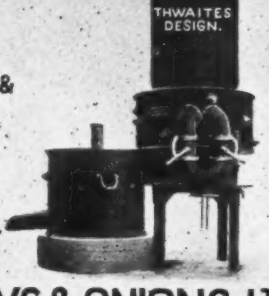

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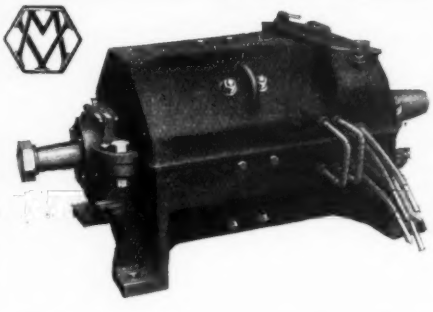

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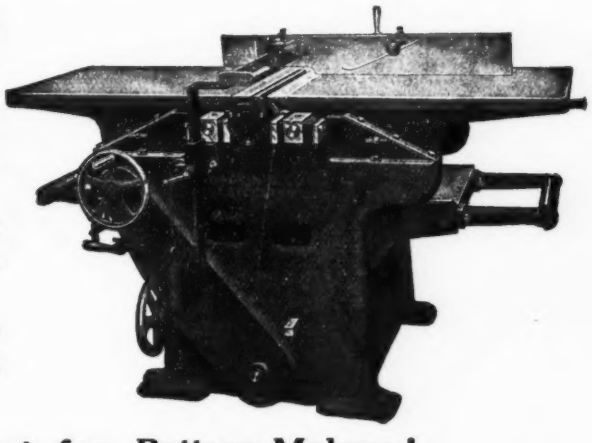

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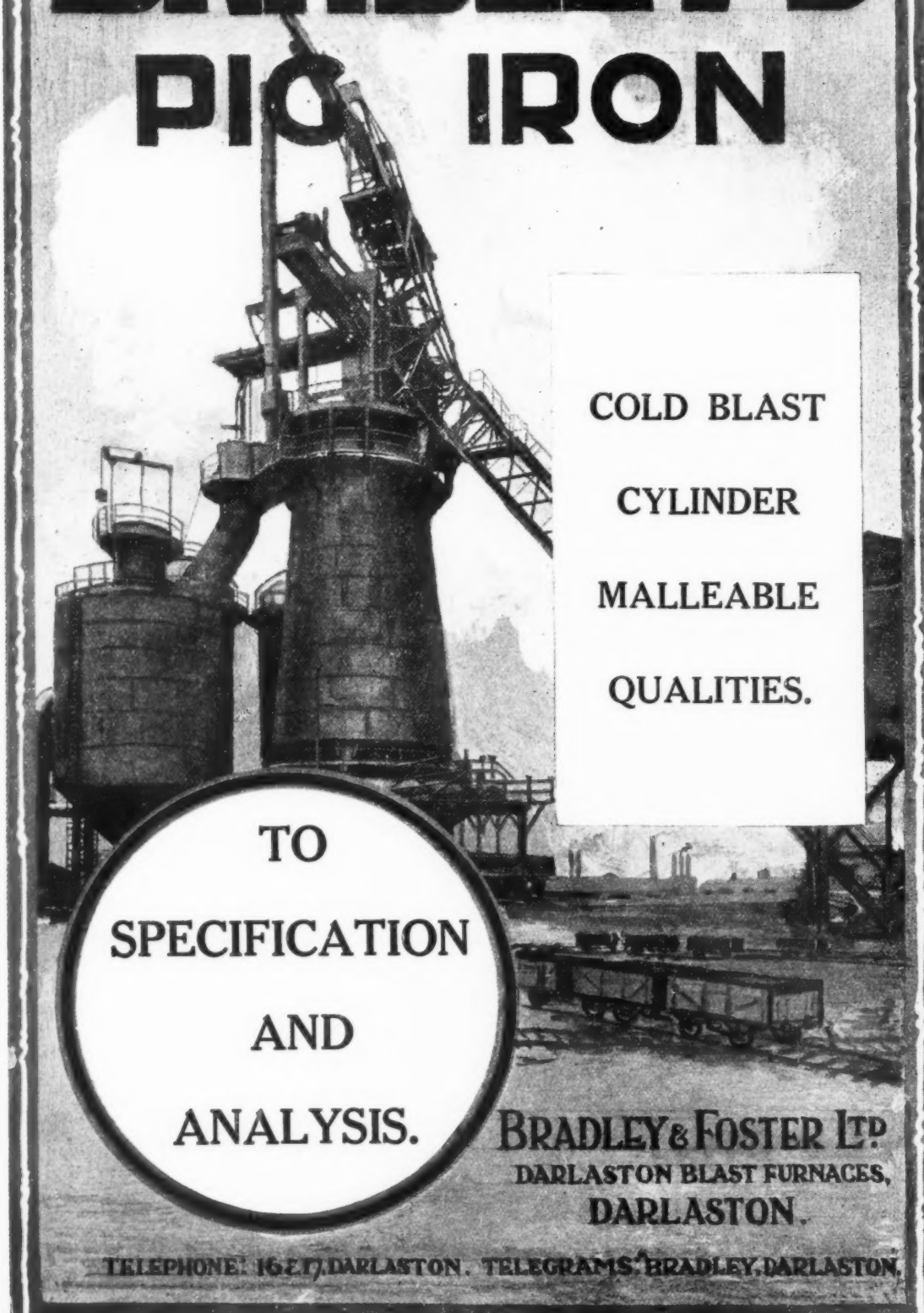

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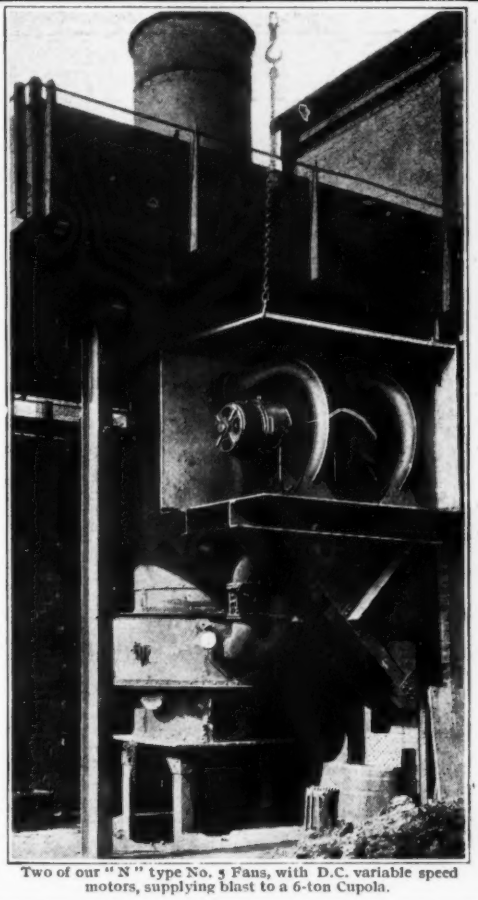

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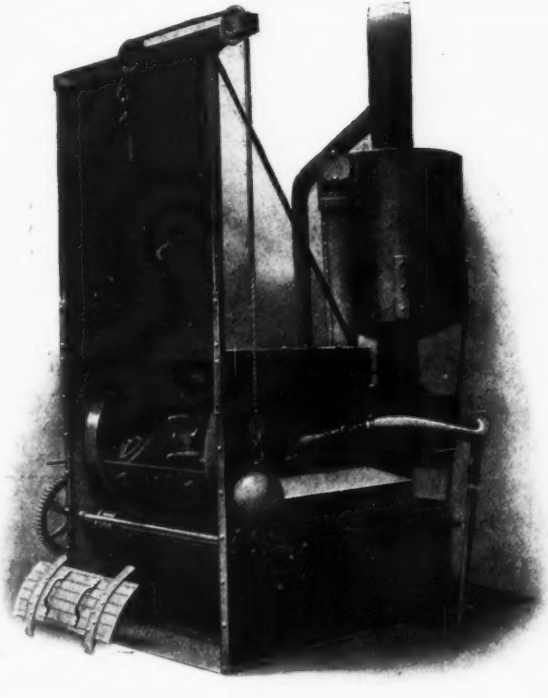

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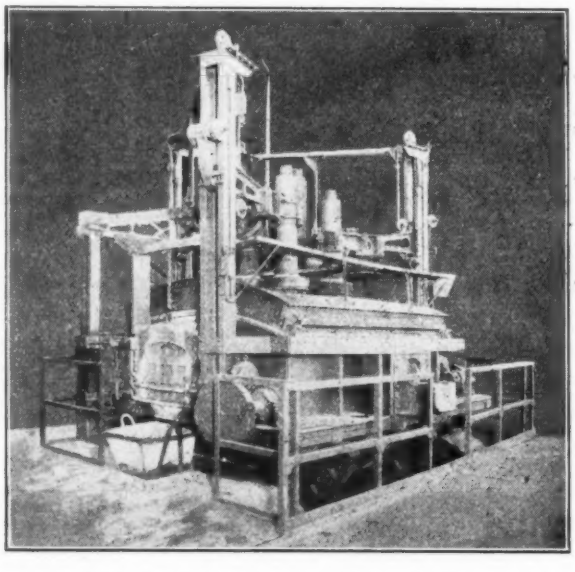

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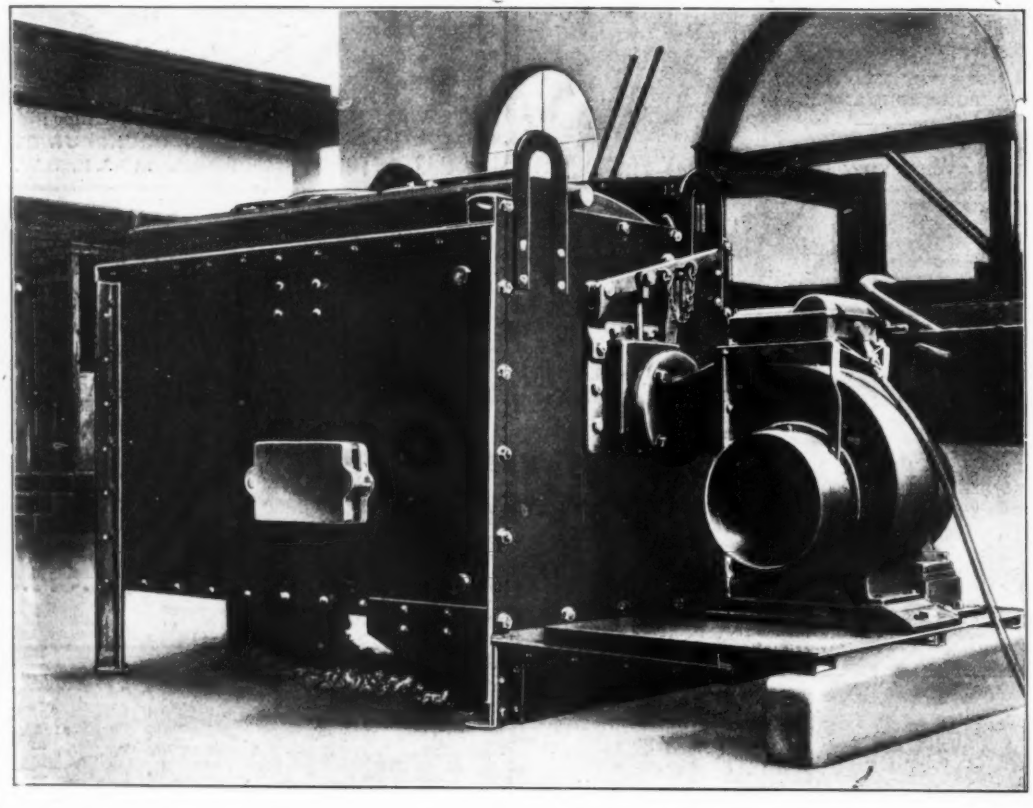

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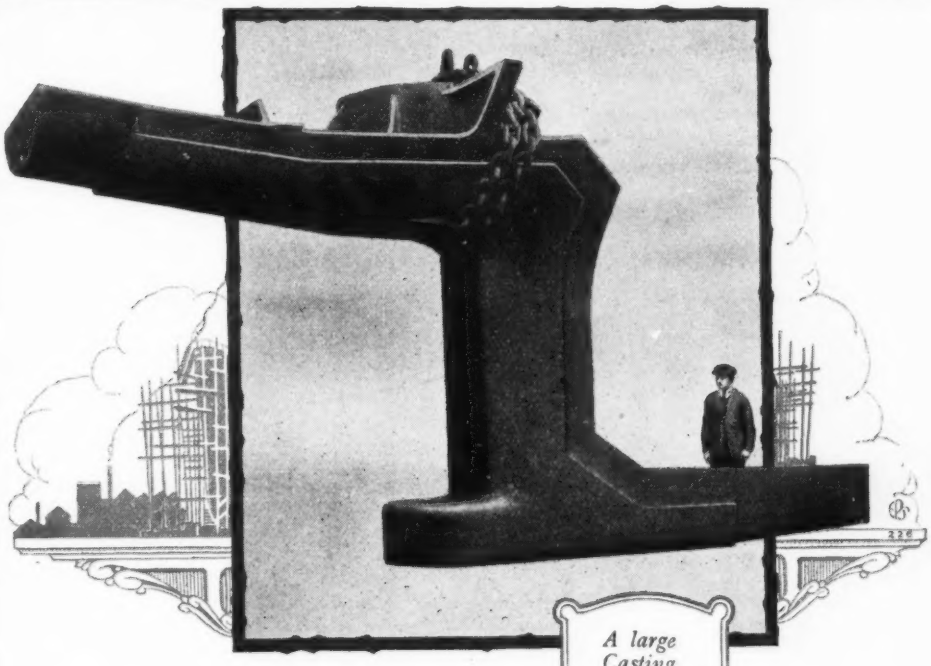

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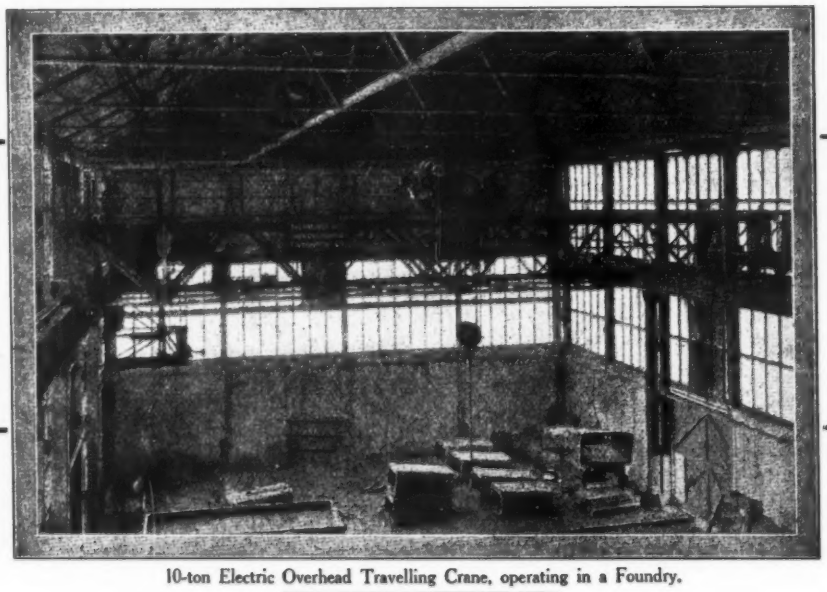

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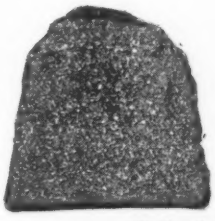

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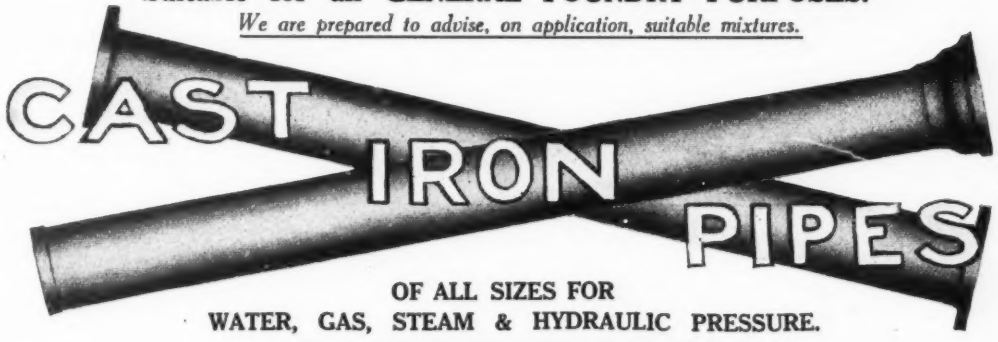

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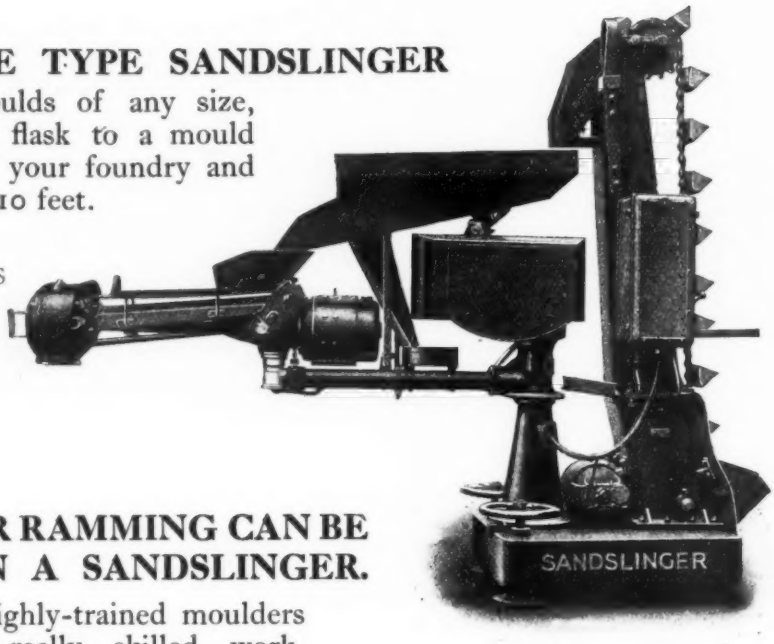

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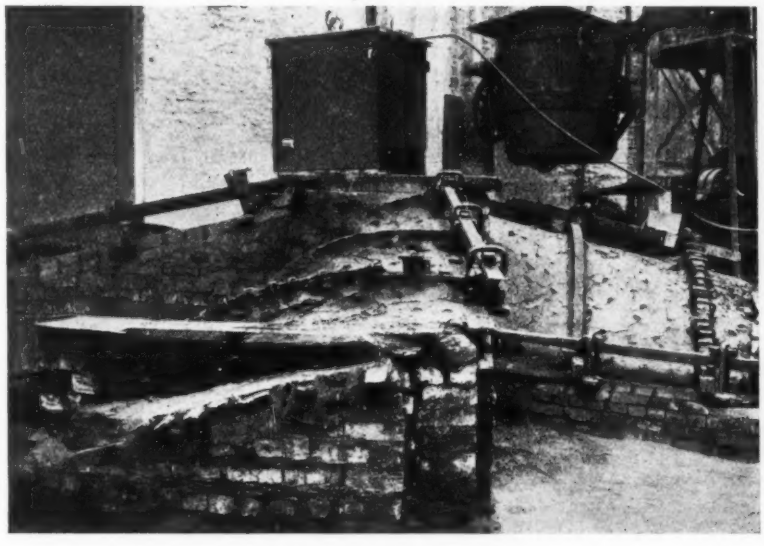

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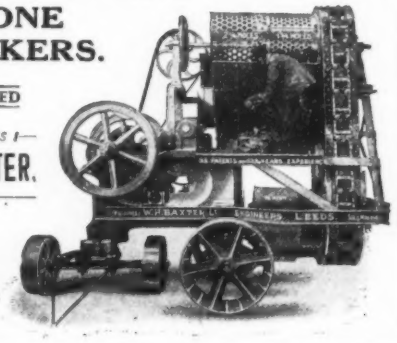

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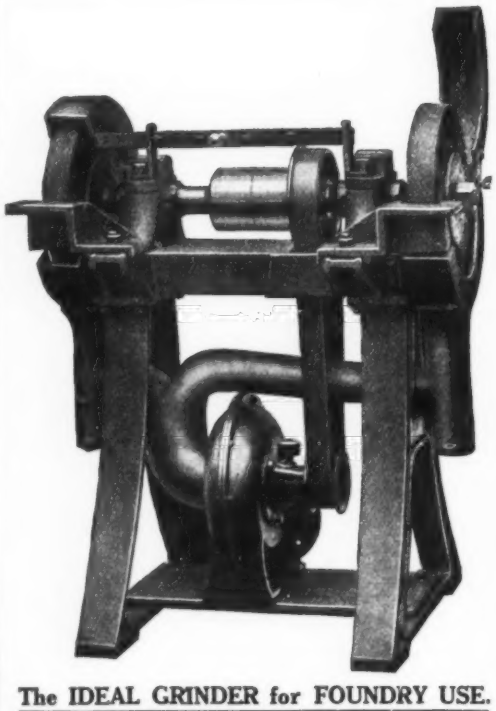

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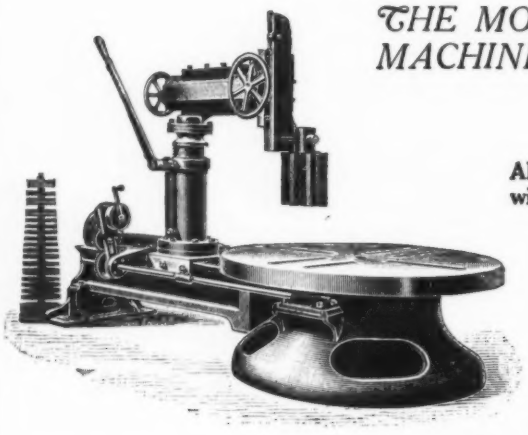

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